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RWA Manual

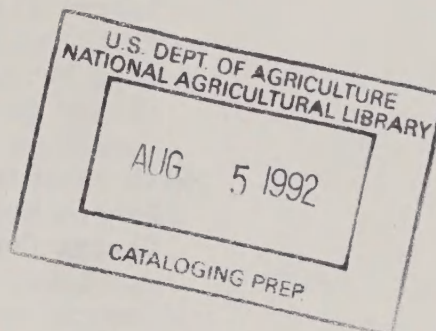
United States  
Department of  
Agriculture

RUSSIAN WHEAT APHID BIOLOGICAL CONTROL PROJECT MANUAL

Animal and  
Plant Health  
Inspection  
Service

Plant Protection  
and Quarantine

Professional  
Development  
Center



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## OVERVIEW OF THE RUSSIAN WHEAT APHID BIOLOGICAL CONTROL PROJECT

### The Aphid Problem

Aphids are small, soft-bodied insects that depend entirely on plants for their existence. Aphids feed on living plants by inserting their piercing, sucking mouth parts into the plant's tissues. Some species also inject a toxin during feeding, causing discoloration, gall formation, or death of the host plant. Many aphids also transmit serious plant diseases, especially those caused by viruses. As a consequence, aphids can seriously reduce crop yield and quality. The degree of damage usually depends on the density of the aphid population.

Hundreds of aphid species occur in the United States. Most species do not achieve high enough densities to cause serious damage to their host plants. However, some aphids are severe, perennial pests of agricultural crops. The ability of an aphid to reach high densities in a particular crop depends on several interacting factors including reproductive capabilities of the aphid, presence of natural enemies, nutritional characteristics of the plant, temperatures, rainfall, and the density of plants in an area. The modern agricultural practice of planting crops in extensive, continuous acreages of a single variety (monoculture) often favors the build up of aphid populations.

One of the major factors that affects the density of an aphid population is the diversity and effectiveness of its natural enemies (parasites, predators, and pathogens). The most effective natural enemies of an aphid are those which have co-evolved with it over long periods of time. Unfortunately, many aphid species in the United States have been accidentally introduced from other countries, leaving their effective, natural enemies behind. Consequently, these exotic species are capable of achieving high densities in many crops and have become severe, perennial pests. In many cases, these same aphids have never been pests in their native lands. Examples of this situation include the greenbug (native to central Europe), spotted alfalfa aphid (native to the Middle East), blue alfalfa aphid (native to Asia), English grain aphid (native to Europe), and Russian wheat aphid (native to Eurasia).

The Russian Wheat  
Aphid Problem

During 1986, a new aphid species was detected on wheat in Texas. The aphid was identified as *Diuraphis noxia*, commonly known as the Russian wheat aphid (RWA). Although RWA is native to Eurasia, it has recently been accidentally introduced into other areas of the world including South Africa during the late 1970's, and Mexico during the early 1980's. Infestations in the continental United States apparently originated from the northward spread of RWA from Mexico. By the fall of 1989, RWA had been found in 16 Western States and 3 Canadian Provinces. Figure 1 shows the distribution of RWA within the United States. See Appendix 8 for a list of counties that are infested with RWA.



Figure 1--Distribution of the Russian Wheat Aphid  
(*Diuraphis noxia*) in the Western United States as  
of January 1, 1992 (Map generated from NAPIS Data  
Base)



RWA reduces the vigor of small grain plants and may transmit plant pathogens. Injection of a toxin by RWA causes white to reddish streaking along the veins of leaves. Margins of infested leaves usually curl upward to form a tube that encloses the feeding aphids. Infestations usually originate on the basal leaves of a tiller, but as the tiller elongates, the aphids continually move upward to the younger leaves. This movement often results in tillers with dead basal leaves and terminal leaves showing discoloration, leaf rolling, or death. Infested plants appear stunted and produce fewer tillers. Tillers often become prostrate rather than remaining vertical. Moderately infested plants produce fewer and smaller grains per head. Heavily infested plants may die. Developing grain heads may also become trapped within terminal leaves curled by the aphid, not allowing the full extension of the head and adversely affecting harvest. Initially, infested fields exhibit patches of plants with RWA damage. As the infestation progresses, patches of affected plants expand and coalesce resulting in large areas of dead or dying plants.

In North America, RWA is primarily a pest of wheat and barley, but infestations have also been observed in oats. Barley is the preferred host crop of RWA. RWA is also capable of surviving on a large number of grass species.

The RWA overwinters at the bases of fall planted grain plants or indigenous grasses. As spring approaches and grain plants begin to grow, the aphids begin to reproduce rapidly. As the plants mature, densities become very high. Winged RWA disperse to spring planted small grain fields initiating new infestations. RWA survives the hot summer months on indigenous grasses and volunteer grain plants and then moves to newly planted grain fields during the fall.

The severity of an RWA infestation in a particular field depends on such interacting factors as climatic conditions, grain cultivars, and proximity to other infested fields.

Conservation Reserve Program (CRP) and fallow fields with volunteer small grains and other RWA susceptible grasses may serve as perennial reservoirs for initiating RWA infestations in surrounding commercial small grain fields.

From 1987 through the 1989 growing season, RWA caused an estimated \$251.5 million damage to wheat and barley production (control costs plus yield losses) in the Western United States. Up to 70 percent yield loss may occur in some fields. The continued spread of RWA can seriously reduce small grain production.

#### Biological Control

Biological control is a method of pest control that uses or manipulates natural enemies to suppress densities of pests to reduce or eliminate pest damage. A basic strategy in biological control is to identify effective enemies of exotic pests in their native regions. An attempt is then made to permanently establish the natural enemies in areas where the pest was introduced. The successful establishment of an effective enemy may permanently reduce the density of the pest to such low levels that it is no longer a problem. Biological control has been used successfully against many pests in the United States, including aphids.

Traditionally, insecticides have been used to temporarily suppress high densities of aphid pests. Concerns over pesticide use have made this method of pest control less desirable or feasible. The negative effects of pesticides include,

- Selection and development of pesticide resistant pests
- Presence of pesticide residues in food
- Contamination of ground water
- Death of beneficial insects

Biological control has received increased emphasis because it has none of these disadvantages.

The RWA is not a serious pest in its native regions of Eurasia and is considered a relatively rare species. Lacking natural enemies, RWA achieves high population

densities in areas where it was introduced. The primary goal of biological control efforts against RWA in North America is to introduce natural enemies from the pest's native regions. The permanent establishment of effective, natural enemies will safely and permanently reduce RWA densities below economically significant levels. Biological control appears to have tremendous potential against the RWA in the United States.

#### The Russian Wheat Biological Control Project

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA, APHIS, PPQ) Russian Wheat Aphis Biological Control Project had its beginnings as the "C7 Project" which began during 1985. The goal of this initial project was to redistribute the beneficial lady beetle, *Coccinella septempunctata* (C7), from established populations in the east to new areas in the west. This goal was successfully accomplished during 1988 and 1989 when several hundred thousand C7 adults were released into sites in California, Nevada, Oregon, and Washington. Establishment of the species at most sites was confirmed during recovery surveys in 1990 and 1991.

During 1986, two new species of European lady beetles, *Hippodamia variegata* (HV) and *Propylea quatuordecimpunctata* (PQ), were discovered to have become established in Eastern Canada and Northeastern United States. In 1987, these two new species were included in redistribution efforts with C7, and the title of the project was modified to the "Aphid Biological Control (ABC) Project." Along with releases of C7, several thousand HV and PQ were released against various aphid pests in several States during 1987 and 1988.

With the continued expansion of RWA in Western States, the ABC Project narrowed its focus from several aphid pests to RWA during 1989. Extensive cooperative activities among personnel from APHIS, Agricultural Research Service, universities, and State Departments of Agriculture were initiated during 1988. During this year, several groups began exploring various areas of Europe and Asia looking for co-evolved natural enemies of RWA in its native regions. Several natural enemies were subsequently

imported beginning in late 1988. Among the predators were various geographic strains of C7, HV, and PQ which helped justify the transition of the ABC Project to become more intensely involved with RWA.

The change in focus of the ABC Project also included the rearing and release of parasites of RWA. Parasite rearing to support the ABC Project was initiated at the Biological Control Laboratory at Mission, Texas, in 1989. Because of the large number of species and strains of natural enemies that were being imported for release, in 1991 APHIS contracted with cooperators at the University of California at Riverside and at the New Jersey Department of Agriculture to begin rearing some of the natural enemies. However, all Project activities and responsibilities are still planned and coordinated from the USDA, APHIS National Biological Control Laboratory at Niles, Michigan.

With the continued intensive focus of the project on the RWA problem, the title of the project was again changed in late 1991 to the "USDA, APHIS, PPQ Russian Wheat Aphid Biological Control Project," or more simply, the "RWA Project."

The initial objective of the RWA Project is to obtain the establishment in North America of one or more effective, natural enemies of this destructive grain pest. Since the ability of any natural enemy to become established or to cause the control of the target pest cannot be predicted, the RWA Project is rearing and releasing nearly all natural enemies that are being imported each year. Initially, high numbers of each natural enemy species are being released into only a few sites in each RWA infested State. These releases primarily are to obtain establishment of one or more species, and not necessarily to immediately control RWA populations. We hope that a natural enemy species does become established immediately and quickly begins to control RWA populations, but it is more likely that control will require several years following establishment of any effective species. When an effective species does become established, then the RWA Project will change tactics and

begin rearing selected species for release in more numerous sites in each infested State (i.e., redistribution). At present, release, recovery, and evaluation samples at past and present release sites are required for the RWA Project to not only determine what becomes established, but also how and when to modify the objectives of the RWA Project to begin redistribution.

Since 1987, the following species and strains of natural enemies have been reared and released by the RWA Project personnel:

Coleoptera: Coccinellidae:

*Adalia bipunctata* (L.)--from Uzbekistan

*Cycloneda ancoralis* (Germar)--from Argentina

*Coccinella septempunctata* L.--from France, Syria,  
Moldavia, Ukraine, Uzbekistan

*Coccinella transversoguttata biinterrupta* (Mader)--from  
Kirghizia

*Eriopis connexa* (Germar)--from Argentina

*Hippodamia tredecimpunctata* (L.)--from Kirghizia,  
Moldavia, Ukraine

*Hippodamia variegata* (Goeze)--from Canada, Chile, France,  
Morocco, Kazakhstan, Kirghizia, Moldavia

*Oenopia globata* (L.)--from Uzbekistan

*Propylea quatuordecimpunctata* (Linnaeus)--from Canada,  
France, Kazakhstan, Kirghizia, Moldavia, Turkey,  
Ukraine



Coleoptera: Coccinellidae: (continued)

*Scymnus frontalis* Fabricius--from Turkey

*Scymnus rubromaculatus*--from France

*Semiadalia undecimnotata* (Schneider)--from Ukraine

Diptera: Chamaemyiidae:

*Leucopis ninae* Tanasijtshuk--from China, Iran, Pakistan,  
Uzbekistan, Yugoslavia

*Leucopis atritarsus* Tanasijtshuk--from Yugoslavia

Diptera: Syrphidae:

*Eupeodes nuda*--from Iran, Kazakhstan

*Sphaerophoria rueppellii*--from Morocco

Hymenoptera: Aphidiidae:

*Aphidius colemani* Viereck--from Pakistan, Jordan

*Aphidius matricariae* Haliday--from Iraq, Moldavia,  
Pakistan, Turkey

*Aphidius picipes* (Nees)--from Czechoslovakia

*Aphidius rhopalosiphi* DeStefani-Perez--from Turkey

*Diaeretiella rapae* (M'Intosh)--from China, France, Iran,  
Jordan, Kazakhstan, Kirghizia, Morocco, Pakistan, Syria,  
Uzbekistan



Hymenoptera: Aphidiidae: (continued)

*Ephedrus plagiator* (Nees)--from Turkey

*Praon gallicum* Stary--from France

Hymenoptera: Encyrtidae:

*Aphelinus asychis* Walker--from Chile, France, Kazakhstan, Pakistan

*Aphelinus* sp nr *varipes* (Foerster)--from Caucasus, China, Iran, Pakistan, Kazakhstan, Turkey, Uzbekistan

See Appendix 6 for more information on predator and parasite releases made from 1987 through 1991.

In 1992, releases will be made into one site in each of the 16 Western States infested with RWA. These release fields will be in new areas of each State, at least 50 miles from previous release sites. The release sites established this year will continue to receive releases through 1994, with recovery surveys initiating in these fields in 1995.

For the first time since focusing on RWA, recovery surveys will be conducted in all previous sites where releases occurred against RWA from 1989 through 1991. Evaluation surveys will be conducted at many of these sites. Recovery and evaluation surveys will continue at these sites through 1994.

Biological control efforts against RWA are based on extensive cooperative efforts among various organizations and countries. Scientists in North America and Europe are involved in various activities to support biological

control, including foreign collections, quarantine screening, and identification. In addition to field activities coordinated by the ABC Project, various universities, State departments of agriculture, and other cooperators are also performing independent release, recovery, and evaluation activities in the United States, Canada, and Mexico.

Research is also being conducted on various other RWA control techniques (plant resistance, chemical control, cultural control, and sampling) to develop an integrated pest management program that will fully resolve the RWA problem. The ABC Project is only one part of this multidisciplinary, multiagency, international, cooperative effort to resolve the RWA problem.

Goal of the RWA  
Project for  
Fiscal Year 1992

The goal of the RWA Project is to implement and coordinate releases, recoveries, and evaluations of exotic, natural enemies of the RWA. During 1992, RWA Project activities to accomplish this goal will include the following three activities that are described in this manual.

1. Releases---

a. Prerelease surveys to locate suitable fields for releasing parasites and predators of RWA. Release fields for 1992 will be at least 50 miles away from previous releases.

b. Release of parasites and predators.

2. Recovery Surveys---

These surveys are designed primarily to determine the presence (establishment) of previously released species. Recovery surveys in 1992 will occur in most 1989, 1990, and 1991 release fields.

### 3. Evaluation Surveys---

These surveys are designed to evaluate not only the presence but also the impact of native and exotic natural enemies of RWA. The surveys will occur at special sites where natural enemies were released against RWA in 1989, 1990, and 1991.

In addition to the above activities described in this manual, the following activities will also be conducted in some States.

1. Cooperative Agricultural Pest Survey (CAPS) to determine the distributions of HV and PQ in Northeastern States, the distribution of C7 in Western States, and the distribution of RWA in all States west of the Mississippi River.

2. Recovery surveys to determine if HV and PQ became established at selected sites where they were released during 1987 and 1988. The States involved are Minnesota, Iowa, Missouri, and Michigan.

These activities will be described in special instructions developed by the Niles Biological Control Lab. Involved States will be notified by the Niles Lab.









## IDENTIFICATION SKILLS

In order to perform the project activities described in this manual, you will need to identify the following:

- The growth stages of wheat, barley, or oats
- RWA damage in a field or on individual host plants
- Aphids, including RWA
- Aphid mummies

### Growth Stages

You must specify the growth stage of host plants in all surveys conducted in fields of wheat, barley, or oats. Growth stages of these cereals are based on the degree of development of the vegetative and reproductive parts of the plant.

For survey activities, consider wheat, barley, and oats as having the following four growth stages (See Figure 2):

1. Tillering--This stage includes all growth from the time the seedling emerges, through the early development of tillers (shoots emerging from the bottom of the original stem). Nodes are not yet present on the stems of the tillers during the tillering stage.

2. Stem extension--This stage begins with the appearance of the first node at the base of a tiller. The stem continues to extend. At the end of this growth stage the inflorescence is enclosed by the terminal leaf sheath or "boot." The inflorescence is not yet visible.

3. Heading--This stage begins when the inflorescence starts emerging from the terminal leaf sheath. This stage continues through the development of watery, ripe kernels.

4. Ripening--This stage includes the development of the kernels from milky ripe to hardened and mature.

When surveying fields of wheat, barley, or oats, you will write the growth stage of the crop on the Field Data Work Sheet (FDWS).

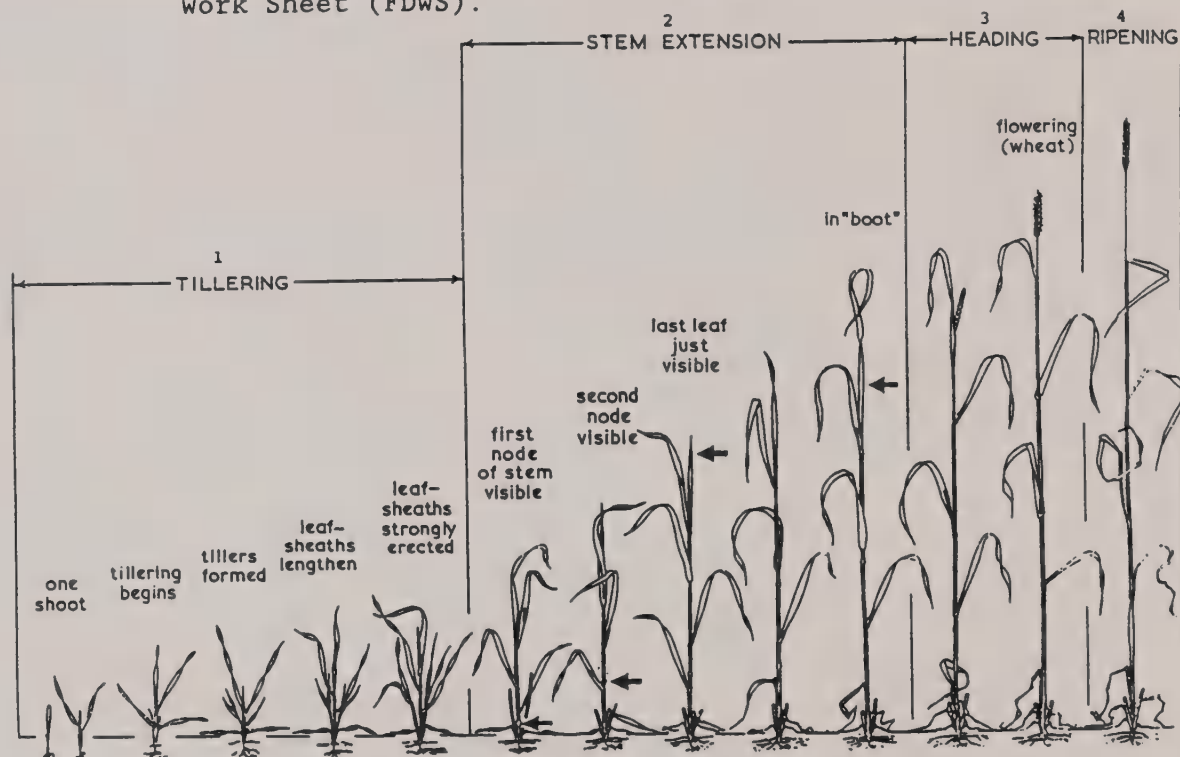


Figure 2--Growth Stages in Cereals

## Aphids

You must recognize aphids in general and RWA in particular. The aphid's small size makes it difficult to observe its distinguishing characteristics. Using a hand lens is often helpful.

Read and study the following identification aids:

- "How to Recognize Aphids," page 15
- "How to Recognize RWA," page 16
- "Russian Wheat Aphid, How to Recognize This New Pest and Its Damage" (enclosed pamphlet prepared by the University of California)

How to Recognize  
Aphids  
(Identification  
Guide)

Most species of aphids have these characteristics:

- Small (less than 3 mm long)
- Tear-drop or pear-shaped
- Usually green, but color may vary
- Soft-bodied
- Distinct cornicles (cornicles indistinct on RWA)
- Long antennae (antennae short on RWA)
- Usually with distinct cauda (short, knoblike tail)
- Usually found in large numbers
- Winged (Figure 3) or wingless (Figure 4)

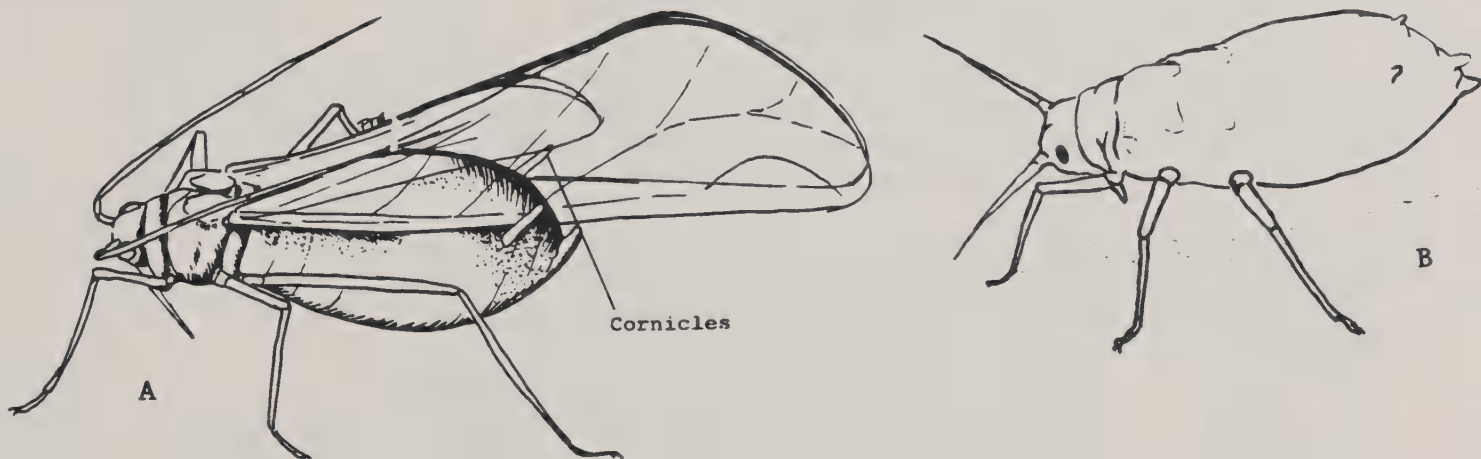


Figure 3 A--Side View of a Winged Aphid  
B--Side View of an RWA

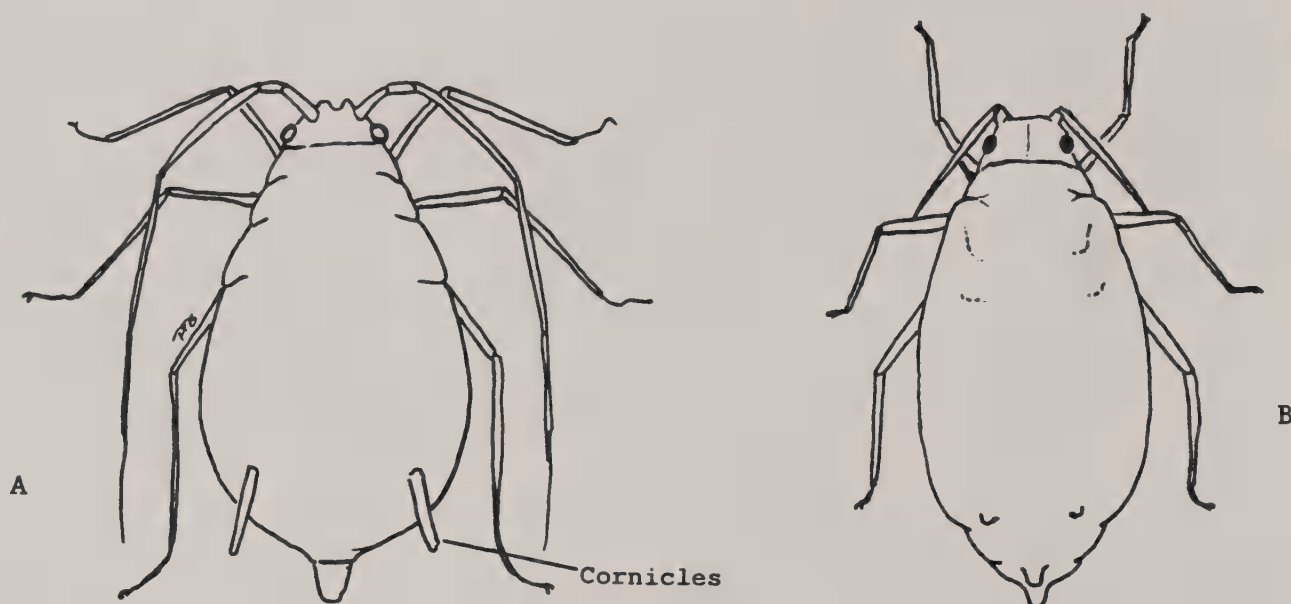


Figure 4 A--Top View of a Wingless Aphid  
B--Top View of an RWA

How to Recognize  
RWA  
(Identification  
Guide)

RWA have these characteristics:

- Same size and shape as most aphids
- Soft-bodied
- Usually found in large numbers
- Yellow-green color
- Short antennae (1/3 or less of body length)
- Cornicles very short and inconspicuous
- Has supracaudal process giving it a "double-tailed" appearance when viewed from the side. The supracaudal process is about as long as the cauda in wingless forms, but is only a short knob in winged forms (Figures 3B and 4B).

See the pamphlet, "Russian Wheat Aphid, How to Recognize This New Pest and Its Damage," prepared by the University of California. A copy of this pamphlet is included with this manual. Study the close-up top view of the RWA that appears in the pamphlet. Note the short cornicles and the supracaudal process. Also note how these structures differ from those found in greenbug, another common grain aphid.

## RWA Damage

When surveying wheat, barley, or oats, you need to recognize the symptoms of RWA damage in the field as well as on individual plants.

### Symptoms on Individual Plants:

RWA feeding can cause the following symptoms on cereal hosts:

- Margins of infested leaves curl downward to form a tube that encloses the feeding aphids
- Leaves develop lengthwise stripes which can be yellow, white, pink, or tan
- Flag leaf or unfurled grain head can curl into a "fish hook" configuration
- Plants can die if heavily infested

These symptoms can be caused by other factors such as herbicide injury or physiological disorders. To distinguish between RWA damage and other types of injury, check inside the curled leaves for the presence of aphids.

For color photographs of RWA damage, see the pamphlet, "Russian Wheat Aphid, How to Recognize This New Pest and Its Damage," prepared by the University of California.

### Symptoms in Fields:

Dead patches of plants can indicate heavy infestations of RWA. Other types of aphids will not normally kill patches of host plants.

## Parasitized Aphids (Aphid Mummies)

Aphids are parasitized by certain species of wasps. Adult parasites lay eggs inside aphids and the immature parasites develop inside the aphid's body. After a parasitized aphid dies, its swollen, brownish or blackish shell remains attached to the leaf surface. This aphid shell with enclosed immature parasite is called a mummy.

See the specimen kits for examples of aphid mummies.









## INTRODUCTION

### Overview

This manual describes the RWA Project activities that will be performed during Fiscal Year 1992. The three major field activities to be conducted are as follows: 1) Locate new fields for releases of RWA natural enemies and perform releases; 2) Conduct recovery surveys at all 1989, 1990, and 1991 release fields; and 3) Take evaluation samples in selected 1989, 1990, and 1991 release fields.

Procedures for releasing exotic parasites and predators of RWA were designed so that their permanent establishment will be accomplished effectively and efficiently. The procedures for releasing the natural enemies are summarized as follows: 1) For 1992 releases, the State Project Coordinator will choose a new area in each State. That new area must be at least 50 miles from previous releases; 2) Within the area chosen for 1992 releases, conduct a prerelease survey of several fields to locate one which is suitable for releases; 3) Release natural enemies into the identified field; and 4) Continue to make weekly releases until the crop has matured or been harvested. Samples are required from the release field on each release date. These samples are used to obtain base-line information on RWA infestation and natural enemy activity to later evaluate the impact of natural enemy mortality on RWA densities. More intensive samples will be required from some fields.

Recovery surveys will be conducted in nearly all 1989, 1990, and 1991 release areas. At each previous release site, the original field and at least three surrounding fields will be sampled weekly. These surveys are to determine if any of the exotic, natural enemies have become established. Sampling procedures have been designed to provide not only qualitative information on species/strains present, but also minimal quantitative information on the possible impacts of any natural enemies that may have become established. Recovery and information on impact are extremely important for determining future RWA Project directions.

Evaluation surveys are conducted only at specific 1989, 1990, and 1991 release sites in California, Colorado, Kansas, Montana, New Mexico, Texas, Washington, and Wyoming. In addition to normal recovery efforts, more intensive sampling will be conducted at the original release field to obtain more extensive quantitative information on the possible impact of established, natural enemies.

Table 1--A List of States Participating in the RWA Project  
Identifying the Activities to be Conducted in Each State

State	Release	Recovery	Evaluation	HV/PQ Recovery 1/
Arizona	x	1	1	
California	x	1	1	
Colorado	x	1	1	
Idaho	x	1		
Iowa				x
Kansas	x	2	1	
Michigan				x
Minnesota				x
Missouri				x
Montana	x	1	1	
Nebraska	x	1		
New Mexico	x	1	1	
Nevada	x	1		
Oklahoma	x	1		
Oregon	x	1		
South Dakota	x	1		
Texas	x		1	
Utah	x	1		
Washington	x	2	1	
Wyoming	x	1	1	

1/ Recovery surveys for HV/PQ at 1988 release sites will be accomplished by specific instructions supplied by the Niles Lab.

The Role and  
Responsibility  
of the State  
Project Coordinator

The State Project Coordinator is in charge of and responsible for all project activities in a State. Responsibilities include--

- Plan and coordinate release and recovery activities
- Order equipment
- Act as liaison between the Niles Lab and field personnel
- Develop and maintain a contact list of cooperators, field personnel, and farmers
- Provide training for field personnel
- Meet with field personnel to plan calendar and review activities
- Record and file survey data
- Report on RWA Project activities (Federal and State)
- Locate areas which contain potential release sites
- Determine where to release parasites and predators
- Entry of data into the National Agricultural Pest Information System (NAPIS) as instructed in Appendix 5

Definitions and  
Abbreviations

**Alfalfa** (*Medicago sativa*)--a legume having compound leaves with three leaflets; widely cultivated for forage and used primarily as a hay crop.

**Aphid**--small, soft-bodied insects of the family Aphidae which feed by sucking sap from plants.

**Aphid mummy**--the term used to refer to a brownish/blackish aphid that has died as the result of parasitization. The immature parasite develops within or directly under the dead aphid.

**Barley**--a cereal having the flowers in dense spikes with long awns and three spikelets at each joint of the rachis.

**CAPS**--the abbreviation used for the Cooperative Agricultural Pest Survey.

**CRP**--an abbreviation used for the ASCS program called the Conservation Reserve Program, which pays farmers for taking crop fields out of production and allowing the fields to lie fallow.

**Clover** (*Trifolium* spp.)--a legume having compound leaves with three leaflets; grown extensively for pasturage, hay, and green manure.

**Density**--the number of insects in a population expressed per unit area, per unit of habitat (e.g., plants, leaf), or per unit effort. For example, the number of aphids collected on the terminal leaf of a barley tiller is density per unit habitat.

**Evaluation Survey**--a survey to assess the success and development of parasites and predators released.

**Field Data Work Sheet (FDWS)**--a form for recording survey results and other information associated with the surveys and releases.

**First Cutting**--the first growth of alfalfa after winter dieback or dormancy.

**Heading**--a cereal growth stage that begins after stem extension when the inflorescence starts emerging from the terminal leaf sheath and continues through the development of watery, ripe kernels.

**Integument**--the exoskeleton (outer covering) of an insect.

**Mission Lab**--USDA, APHIS Biological Control Lab, P.O. Box 2140, Mission, Texas 78572.

**Niles Lab**--USDA, APHIS Biological Control Lab, 2534 S. 11th Street, Niles, Michigan 49120, (616) 683-3563, FTS 333-8212.

**Oats**--(*Avena sativa*) a grass of the genus *Avena* which is widely cultivated for its edible seeds and is also used as a fodder.

**Petiole**--a slender stem that supports the blade of a foliage leaf; leafstalk.

**Prerelease Survey**--a survey to identify fields which best meet criteria for releasing parasites and predators.

**RWA**--the abbreviation used for the Russian wheat aphid *Diuraphis noxia*.

**Recovery Survey**--a survey to determine if releases of aphid parasites and predators made during previous years have resulted in the permanent establishment of a population. Part of evaluation surveys at sites where releases have been made against RWA.

**Release**--to introduce aphid parasites and predators into fields with optimal conditions for population growth and establishment.

**Release area**--an area within a state which is most likely to have fields and an environment to support the establishment of exotic aphid parasites and predators. The area is selected by the State Project Coordinator and delimits the area in which the Prerelease survey is conducted.

**Release site**--a location where aphid parasites and predators were or will be released.

**Ripening**--a cereal growth stage that begins after heading and includes the development of the kernels from milky ripe to hardened and mature.

**Serrated**--sawlike; describes the toothed margin of a leaf.

**State Project Coordinator**--the person in charge of the RWA Project in a particular State.

**Stem extension**--a cereal growth stage that begins after tillering with the appearance of the first node at the base of a tiller and ends when the inflorescence is enclosed by the terminal leaf sheath or "boot." The inflorescence is not visible.

**Tiller**--a shoot, especially one that sprouts from the base of a grass.

**Tillering**--a cereal growth stage that includes all growth from seedling emergence through early development of shoots (tillers) emerging from the bottom of the original stem.

**Wheat**--any of various cereal grasses of the genus *Triticum*, especially *T. aestivum*, widely cultivated in many varieties for its commercially important edible grain.







RELEASE  
Introduction

The primary activity of the RWA Project during 1992 is to release exotic parasites and predators of the RWA into RWA infested areas of the United States. The goal of these releases is to permanently establish the parasites and predators. When making releases, as many biological and ecological factors are taken into consideration as possible to increase the likelihood that the natural enemies will survive, reproduce, and become established in the release area. Selection of a release field, timing of releases, and method of release are important factors in trying to establish parasites and predators.

During 1992, new areas at least 50 miles away from previous releases will be used for releasing natural enemies. Parasites and predators will be released into CRP land or commercial fields of small grains (barley, wheat, oats) infested with RWA. Situations where release fields are located nearby or next to alfalfa or clover fields are preferred since they provide a perennial habitat for natural enemies when grain plants are mature or harvested.

Releases will be made in the following States:

Arizona	Nevada
California	Oklahoma
Colorado	Oregon
Idaho	South Dakota
Kansas	Texas
Montana	Utah
Nebraska	Washington
New Mexico	Wyoming

All States will make weekly releases of both parasites and predators into a single field. Strains of parasites and predators from Canada, Europe, Asia, and South America will be released this year. Since explorations for exotic parasites and predators are ongoing, there may be new species and strains added to the arsenal of RWA natural enemies for release. See Table 1, next page, for a list of natural enemies that will be released during 1992.

Table 1--Codes for RWA Natural Enemies Being Reared for  
1992 Releases

Species:	Geographic collection site:	Import identification number	Acronym:
<u>Coleoptera:</u>			
<u>Coccinellidae:</u>			
<i>Hippodamia variegata</i> (Goeze) [EPA=INAPBEA]	Santiago, Chile	PSRF9002	HvarCS90
<i>Propylea</i> <i>quatuordecimpunctata</i> (Linnaeus) [EPA=INAPBFA]	Dmitrievka, Kazakhstan Chaek, Kirghizia	BIRL91095 BIRL91096B BIRL91096A	HvarKD91 PquaKD91 PquaKC91
<u>Diptera: Chamaemyiidae:</u>			
<i>Leucopis ninae</i>	Wugia, China	T91085	LninCW91
<i>Tanasijtshuk</i> [EPA=IOCSADA]	Yining, China Dashtak/Varamin, Iran Parachinar, Pakistan Tashkent, Uzbekistan	T91095 T91066 T91056 T91083	LninCY91 LninID91 LninPP91 LninUT91
<u>Diptera: Syrphidae:</u>			
<i>Eupeodes nuda</i> [EPA=	Fars, Iran Dmitrievka, Kazakhstan	T91065 T91059A	EnudIF91 EnudKD91
<u>Hymenoptera: Aphidiidae:</u>			
<i>Aphidius matricariae</i> Haliday [EPA=ISBUAJA]	Kishinev, Moldavia NWFP, Pakistan	T90067 T90003	AmatMK90 AmatPN90
<i>Diaeretiella rapae</i> (M'Intosh) [EPA=ISBUTAPA]	Wugia, China Ehglid, Iran FARS, Shiraz, Iran Dmitrievka, Kazakhstan Parachinar, Pakistan Qatara, Syria Tashkent, Uzbekistan	T91084 T90051 T91050=T91064 T91089 T91037 T90026 T91150	DrapCW91 DrapIE90 DrapIF91 DrapKD91 DrapPP91 DrapSQ90 DrapUT91

Table 1--Codes for RWA Natural Enemies Being Reared for  
1992 Releases (Continued)

Species:	Geographic collection site:	Import identification number	Acronym:
<u>Hymenoptera: Encyrtidae:</u>			
<i>Aphelinus asychis</i> Walker [EPA=ISBLAKA]	Chillan, Chile	T90116	AasyCC90
	Dmitrievka, Kazakhstan	T91061	AasyKD91
	Parachinar, Pakistan	T92062	AasyPP91
<i>Aphelinus</i> sp nr <i>varipes</i> (Foerster) [EPA=ISBLAJA]	Budennovsk, Caucasus	T91086	AvarCB91
	Altai, Hebukesir, China	T91102+T91107	AVARCA91
	Yining, China	T91093	AvarCY91
	Fars, Shiraz, Iran	T91063+T91049	AvarIF91
	Parachinar, Pakistan	T91043	AvarPP91
	Dmitrievka, Kazakhstan	T91057	AvarKD91
	Kustanay, Kazakhstan	T91110	AvarKK91
	Tashkent, Uzbekistan	T90076	AvarUT90

Release activities include the following--

1. Select or identify an area within the State (done by the State Project Coordinator)
2. Conduct a Prerelease Survey
3. Release parasites and predators

Figure 5 shows the progression of activities involved in releasing parasites and predators.



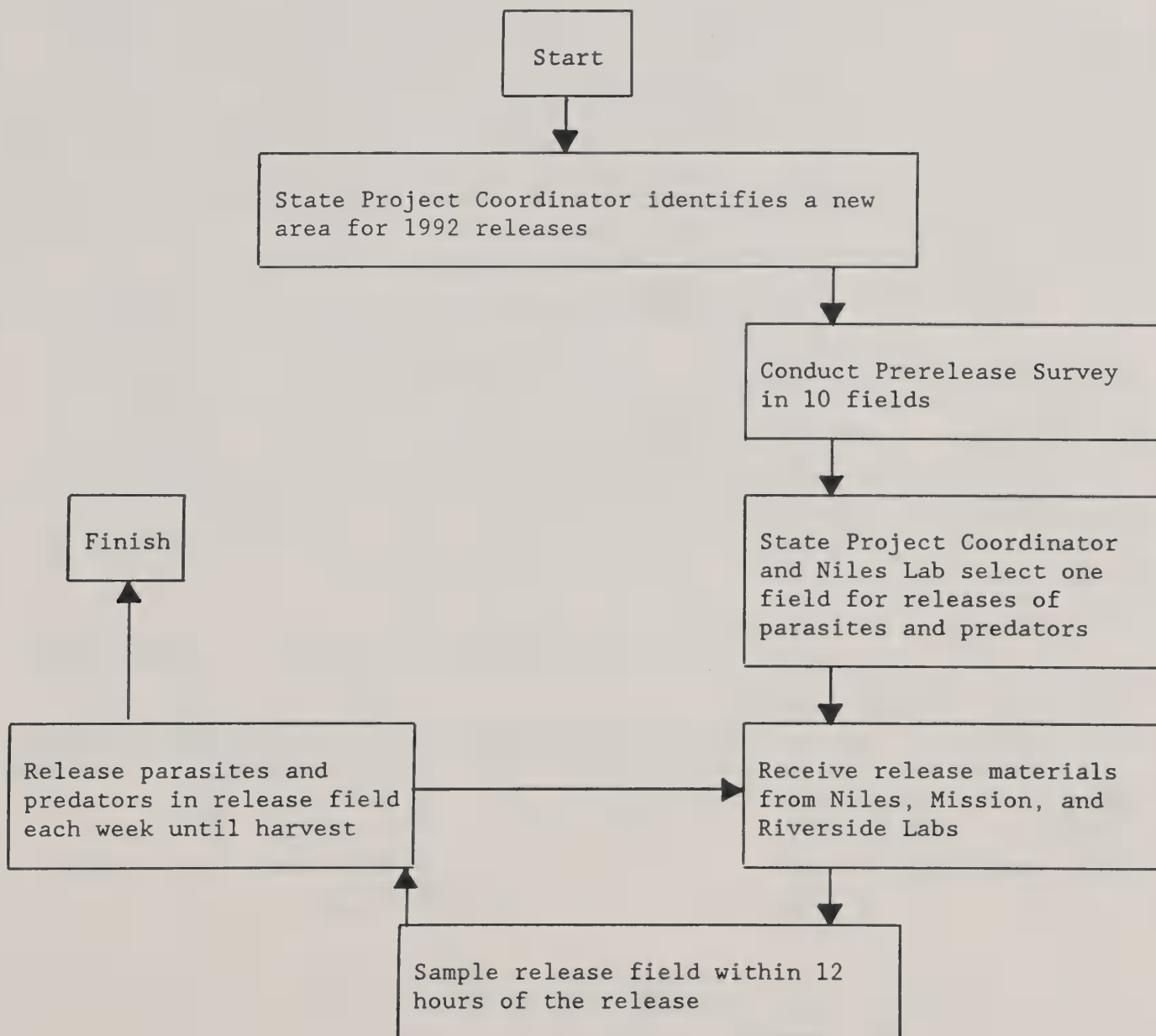


Figure 5--A Flowchart Indicating the Progression of Activities Involved in the Release of Exotic Parasites and Predators Against the RWA



The Prerelease Survey involves sampling 10 fields in the release area for the State. The release area must be at least 50 miles away from previous release fields. The survey is designed to locate fields within the area that are suitable for release by determining the aphid and native parasite and predator densities in the fields. The survey will begin when spring growth begins in the geographic area of the release. One release field will be selected by the State Project Coordinator, in consultation with Niles, based on Prerelease Survey data.

The release field will be sampled within 12 hours before or after making each release. The samples will provide information on the conditions present in the fields when releases are made, as well as the presence of any aphid natural enemies. Releases will be made in the field at sunset, preferably on the day the release materials are received. If you must hold the parasites and predators overnight, then place them in the top shelf of a refrigerator. You must make the release within 2 days of receiving the release material.

Consecutive releases will be made in the release field over a 4 to 6 week period. You will sample the release field each time before you make a release.

Questions Not  
Answered or  
Material Not  
Covered

If you have any questions on information covered in this manual, contact your State Project Coordinator.

RELEASE  
Prerelease Survey--Methods and Procedures

Overview

Here's an overview of the steps involved in the Prerelease Survey:

Step 1--Locate Fields to Sample

Step 2--Determine When to Sample

Step 3--Sample Fields and Record Data

Step 4--Complete an FDWS

Step 5--Continue the Survey

Step 6--Get Commitment from Farmer/Landowner

Step 7--Contact Niles Lab

Equipment Needed

Most equipment needed will be supplied by the Niles Lab. The RWA Survey Packs will be sent to you well in advance of the survey season. See Appendix 7 for a list of the contents.

Hand lenses will not be supplied by Niles. See Appendix 1 for possible supply sources.

Step 1--Locate  
Fields to Sample

Locate at least 10 fields of CRP land, barley, wheat, or oats within the area designated by your State Project Coordinator. CRP fields with small grains in them are ideal since they are perennial, not sprayed, and not harvested. However, sampling in these fields is difficult. The best situation is to choose a wheat or barley field for release but with an adjacent CRP field. Spring planted fields are preferable to winter wheat.

Locate fields to survey during late winter or early spring. Inform the county Agricultural Extension agent(s) of the project and ask for possible field locations, especially farmers who do not use insecticides. Ask the agent if there are any organic farms in the area.

Use the following criteria for selecting fields:

- Wheat or barley fields with adjacent CRP fields are preferred
- Spring planted fields are preferred over winter wheat fields
- No insecticides used in fields for past 3 months
- RWA present in field or vicinity during previous years
- Surrounding areas contain both disturbed and undisturbed vegetation (e.g. wild grasses, brush lots, wooded areas, weedy fields, roadsides)
- Near other crops that harbor aphids throughout the season--sorghum, alfalfa, clover, corn, sugar beets, potatoes

Once you have located a potential sample field, get the farmer's/landowner's permission to sample the field. Inform the farmer/landowner that initial sampling in the field is only to determine suitability for releasing parasites and predators. Releases cannot be guaranteed in any field prior to sampling. The farmer/landowner must understand that even if releases of parasites and predators are made, control of RWA and other aphids will not occur immediately and may take several years. Discuss with the farmer/landowner his/her attitude toward insecticide applications. If you feel that the farmer would apply insecticides after releases are made, then do not include the field in the Prerelease Survey.

Step 2--Determine  
When to Sample

For fall planted crops (e.g., winter wheat) and CRP fields, begin sampling once spring growth begins. For spring planted crops, begin sampling when the plants begin to tiller.

Step 3--Sample  
Fields and  
Record Data

Follow these procedures when sampling a field:

1. Walk at least 15 paces into the field.
2. Randomly select a nearby tiller and gently cut it at its base. In CRP fields, select only tillers from grain plants in the field. Examine the entire tiller closely for the presence of aphids. Tally the number of infested and noninfested tillers examined in Block 9 of the FDWS. For

tillers with aphids, if the aphids are not RWA, then keep track of these tillers separately from those with RWA (tally tillers with and without RWA in separate areas of Block 9).

3. Walk at least 10 paces in any direction and repeat 1 and 2 above until you've examined 100 tillers. Take tillers from as many diverse areas in the field as possible.

4. Total the number of infested (RWA and others) and noninfested tillers in Block 9 of the FDWS.

If you count	Then:
Four or fewer infested tillers	<ul style="list-style-type: none"><li>• Collect another 50 tillers following the instructions covered in 1 through 4 above, and</li><li>• Go to the next step</li></ul>
Five or more infested tillers	Go to the next step

Step 4--Complete  
an FDWS

The FDWS is a record of your survey and supplies information needed by the State Project Coordinator and the Niles Lab.

\* U.S. GOVERNMENT PRINTING OFFICE: 1989-243-265

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Follow these instructions to complete the FDWS. Print all information legibly.

<u>Block Number</u>	<u>Instruction</u>
1-7, 24-27, 30 & 31	Leave blank
8	Fill in State--two-letter postal designation Site--leave blank Field--number of field in area (1-10) Sample number--sample number for this field
9	Separately tally the number of noninfested tillers, tillers infested by RWA, and tillers infested by other aphids
10	Check box for "Pre-Release Survey"
11-22, 33 & 34	Write appropriate information for each item
14	Use nearest longitude and latitude
23	Check appropriate box Stand age--For CRP fields, indicate years as CRP. If other than CRP, indicate whether spring or fall planted. Growth stage--write one of the following: Tillering Stem Extension Heading/Flowering Ripening Plant Height--leave blank
28	Check "no" unless insecticide has been used

<u>Block Number</u>	<u>Instruction</u>
29	Draw a map of the field with enough detail that someone other than you can find the field. You only need to draw a map during your first visit to the field. Include the following: <ul style="list-style-type: none"><li>● Field location in relation to road or highway</li><li>● Easily identifiable landmarks</li><li>● Approximate distance from nearest town</li></ul>
32	Write any appropriate remarks. Make a note if farmer is receptive to biological control. Note severe weather conditions.

Distribute\* the FDWS original and copies as follows:

- Original--mail to Niles Lab
- Pink copy--mail to the State Project Coordinator
- Yellow copy--keep for your records

Step 5--Continue  
The Survey

Continue to survey once a week in all the fields you have located. Your State Project Coordinator will tell you when to discontinue surveying particular fields. The State Project Coordinator, in consultation with Niles, will drop fields from the survey based on the criteria listed in Appendix 3. Also, the State Project Coordinator, in consultation with Niles, will select one field to receive parasites and predators based on the criteria listed in Appendix 4.

Step 6--Get  
Commitment From  
Farmer/Landowner

Once the State Project Coordinator, in consultation with Niles, has selected a release field, you will need to contact the farmer/landowner. Before you can release

\*Envelopes are included in the equipment package.



parasites and predators you must obtain a firm commitment from the farmer/landowner to abide by the following conditions:

- Not to apply insecticides for at least 3 months before and 1 year after release. If fields must be sprayed after release, leave a 2 to 5 acre area untreated where releases occurred. If possible, land surrounding the field should not have had insecticide applied.
- Allow repeated entry in field by authorized personnel to make releases and to take samples
- The farmer/landowner must understand that releases of parasites and predators will not immediately control aphids. It may take several years before effective control is obtained.

Step 7--Contact  
Niles Lab

The State Project Coordinator will contact the Niles Lab once the field is selected and the farmer/landowner has agreed to abide by release conditions. During this conversation, the first release date will be determined based on sampling data from the field and current weather conditions. The Niles Lab should be contacted approximately 1 week before the State Project Coordinator anticipates release since the parasites and predators must be fed and conditioned in the lab for several days before shipment.

RELEASE  
Release Parasites and Predators--Methods and Procedures

Overview

Here's an overview of the steps involved in the release of parasites and predators.

Step 1--Receive Shipment of Parasites and Predators

Step 2--Sample the Release Field and Record Data

2a--Determine Tiller Infestation Rate

2b--Conduct Timed Searches for Parasitized Aphids

2c--Take Sweep Samples for Aphid Predators

2d--Complete an FDWS Attachment

2e--Complete Sample Labels

Step 3--Release Natural Enemies of RWA

3a--Release Predators

3b--Release Parasites

Step 4--Complete an FDWS

Step 5--Mail Shipping Containers back to Niles, Mission,  
and Riverside Labs.

Step 6--Continue Releasing Parasites and Predators

Equipment Needed

Most equipment needed will be supplied by the Niles Lab. RWA Survey Packs will be sent to you in advance of the survey season. See Appendix 7 for a list of the contents.

Sweepnets and sweepnet replacement bags will not be supplied by the Niles Lab. See your State Project Coordinator for these supplies or refer to Appendix 1 for a supply source.

Step 1--Receive  
Shipments of  
Parasites and  
Predators

Predators and parasites will be sent from the Niles, Mission, and Riverside Labs by overnight delivery. All shipments will be coordinated by the Niles Lab. Each shipment will have either a predator or parasite shipment receipt form enclosed. At most locations, shipments will arrive by 10 a.m. on the previously arranged date.

Open the boxes to make sure the insects are still alive and to confirm what is present. Do not unpack the box until you are in the release field and are ready to release the parasites and predators.

Release parasites and predators on the same day that you receive them. If you cannot release on the day of receipt, then store the insects on the top shelf of a refrigerator. The insects must be released within 36 hours of receipt.

Plan to make your releases just before (1 hour), at, or just after sunset. By making releases at sunset, you will reduce the likelihood of released insects flying out of the release field.

Step 2--Sample  
the Release Fields  
and Record Data

The field must be sampled on each date of release. Sample the release field within 12 hours before or after making the release. In each of three separate areas of the field, obtain the following data:

Step 2a--Determine Tiller Infestation Rate:

1. Walk at least 15 paces into the field.
2. Randomly select a nearby tiller and gently cut it at its base. In CRP fields, select only tillers from grain plants in the field. Examine the entire tiller closely for the presence of aphids. Tally the number of infested and noninfested tillers examined in Block 36 of the FDWS Attachment. For tillers with aphids, if species of aphids other than RWA are present, then keep track of these tillers separately from those with RWA present.

3. Walk at least 10 paces in any direction and repeat 1 and 2 above until you've examined 50 tillers in the area. Take tillers from as many diverse areas in the field as possible.

4. In release fields in California, Colorado, Kansas, Montana, New Mexico, Texas, Washington, and Wyoming only, place the first eight RWA infested tillers you find in each area of the field into individual plastic bags (note that there may be fewer than eight infested tillers per area when field infestation rates are low). After completing the tiller sampling in the area, return to the vehicle and process the individual RWA infested tillers. Gently detach each infested leaf from each tiller and place all infested leaves from a tiller into an individual 4 oz. container of alcohol. Do not bend the rolled leaves. Gently curl the leaves into the container with as little deformation as possible. Use separate containers for each tiller. Indicate the number of infested tillers ( = containers) that you processed in each area of the field.

5. Repeat 1 to 4 above in the other two areas of the field. On each sampling date, new areas in the field should be selected for sampling.

Step 2b--Conduct Timed Searches for Parasitized Aphids:

1. Return to the field and walk in at least 15 paces from the edge.

2. With a wristwatch, note the time and then begin searching for mummified aphids in the field. Search all areas of the plant including the base and grain head. Some aphids parasitized by certain species of parasites may wander from the original plant, so check weeds, sticks, rocks, etc., as well as the grain plants. Continue to search for a total of 15 minutes in the area--note that if three people are searching the area, then each would search for 5 minutes to obtain a total of 15 minutes of effort. In release fields in California, Colorado, Kansas, Montana, New Mexico, Texas, Washington, and Wyoming, search for 20 minutes.

3. When conducting the search, collect all the mummies. Do not detach a mummy from the substrate to which it is attached--collect the mummies with a piece of the attached plant material or other substrate.

4. When the timed search in the area is completed, take the mummies back to the vehicle and begin processing them. With a pair of small scissors, gently cut any extra plant material or other substrate away from the attachment location of the mummy. Place each mummy with a small piece of the attached substrate into a capsule and close the capsule with the attached cap. Place only a single mummy in a capsule. Do not jam the capsule full of extraneous plant material--it will crush the mummy. Place only a single mummy into a single capsule. Place all the mummies found in an area into a resealable plastic bag (one bag per area).

5. Record the number of mummies found in each area in the appropriate location in Block 37 of the FDWS Attachment.

6. Repeat 1 to 5 above in each of the other two areas of the field.

Step 2c--Take Sweep Samples for Aphid Predators:

1. Walk at least 15 paces into the field from the edges.

2. Take 100 sweeps with the sweepnet.

3. Walk back to your vehicle. Dump the contents of the sweepnet into a sorting pan and remove all plant parts, large insects such as grasshoppers, crickets, bees, and wasps from the samples. Place all the remaining insects from the sweep sample into a 4 oz. jar with alcohol. Note that samples from each area of the field will be placed in separate jars.

4. Repeat 1 to 3 above in each of the other two areas of the field.

\*\*\*\*\* FDWS ATTACHMENT - RWA SAMPLING FORM \*\*\*\*\*

35. SITE DESIGNATION CODE      UT   -   9201   -   4   -   4-2-92

STATE                      SITE                      FIELD                      DATE DATA TAKEN

\*\*\*\*\*

36. TILLER INFESTATION RATE

	AREA 1	AREA 2	AREA 3	TOTAL
APHIDS ABSENT	 	 	 	122
APHIDS PRESENT			1	26
- RWA + OTHERS				
- OTHERS ONLY		0		7

\*\*\* FOR INTENSE EVALUATION FIELDS ONLY:

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF RWA INFESTED TILLERS SENT				

\*\*\*\*\*

37. PARASITE ABUNDANCE - TIMED SEARCH

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF MUMMIES FOUND	14	47	5	66

LAB USE ONLY	AREA 1	AREA 2	AREA 3	TOTAL
# SPECIMENS RCVD				
# MUMMIES				
- # VIABLE				
- # NOT VIABLE				

\*\*\*\*\*

38. PREDATOR ABUNDANCE - SWEEP NET SAMPLES

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF SWEEPS	100	100	100	300

Figure 7--An Example of a Completed FDWS Attachment for  
the Release Survey



Step 2d--Complete an FDWS Attachment:

Follow these instructions to complete the FDWS Attachment. Use the sampling information from the field. Print all information legibly.

<u>Block number</u>	<u>Instruction</u>
35	Fill in same as Block 8 on FDWS. Indicate sample date.
36	Tally the numbers of tillers infested by RWA separately from those tillers infested by other aphids (no RWA present). Tally marks must be recorded separately for each of the three areas of the field.  If this is a field designated for intense evaluation survey (California, Colorado, Kansas, Montana, New Mexico, Texas, Washington, and Wyoming), then indicate the number of RWA infested tillers processed in each area of the field. Note that there should be a jar associated with each infested tiller.
37	Indicate the number of mummies found during the 15 or 20 minute search in each of the three areas of the field.
38	Indicate the number of sweeps taken in each of the three areas of the field.

Step 2e--Complete Sample Labels:

The accurate completion of labels is an essential part of the field work. Please pay special attention to properly completing the following items.

Use a pencil to complete all labels. Ink will dissolve in alcohol, thus making the enclosed specimens worthless. Print all information legibly.



Resealable Plastic Bags of Mummies:

On the white area on the exterior of the bag, write with a pencil "Release," the State, the sample date, and the area of the field from which the mummies in the bag came from (e.g., 1, 2, or 3).

Place the three bags of mummies into a shipping tube with the original FDWS, FDWS Attachment, and all Shipment Receipt Forms (in a release field). Ship these mummies and forms to the Niles Lab by overnight or next-day delivery service (Express Mail, Airborne Express, UPS, Federal Express, etc.). Pre-addressed labels are included in your equipment packages. Ship the mummy samples within 12 hours after sampling the field.

Jars from Sweep Net Samples:

SAMPLE LABEL	
(1) SURVEY	Sweep Rel
(2) STATE	UT
COUNTY	Summit
(4) SITE	Release
FIELD	Area 2
(6) DATE	4-2-91
(7) COLLECTOR	Jim Jones

Figure 8--An Example of a Sample Label for Jars From Sweep Net

- (1) Write "Sweep-Rel"
- (2) Write two-letter postal abbreviation for State.
- (3) Write county where field is located.
- (4) Write "Release."
- (5) Write the area of the field from which the sample came (e.g., 1, 2, or 3).
- (6) Write the sample date.
- (7) Write your name.

Place a completed sweep sample label into each jar--one jar per area of the field. Make sure the lids of the jars are tightly closed! Place the three jars into a mailing tube and add some wadded paper towelling to reduce movement of the jars. Ship the mailing tube with the pre-addressed, franked mailing labels to the Niles Lab. The tubes should be shipped by regular mail, but get them to the post office within 24 hours after taking the sample.

Jars of Leaves From Infested Tillers--Intense Survey Fields Only:

SAMPLE LABEL	
(1) SURVEY	Tiller - Rel
(2) STATE	UT
COUNTY	Summit
(4) SITE	Release
FIELD	Area 1
(6) DATE	4-2-91
(7) COLLECTOR	Jim Jones

Figure 9--Example of a Sample Label for Jars of Leaves From Infested Tillers

- (1) Write "Tiller-Rel"
- (2) Write two-letter postal abbreviation for State.
- (3) Write county where field is located.
- (4) Write "Release."
- (5) Write the area of the field from which the tiller came (e.g., 1, 2, or 3).
- (6) Write the sample date.
- (7) Write your name.

Place a completed tiller sample label into each jar--one jar per tiller and as many as 24 jars per field. Make sure the lids of the jars are tightly closed! Place the jars back into the box in which they came in. Add some wadded paper towelling to reduce movement of the jars. Ship the



box to the Niles Lab. The box should be shipped by regular mail, but get it to the post office within 24 hours after taking the sample.

Step 3--Release  
Natural Enemies  
of RWA

Release parasites and predators the same day you receive them. If you cannot release on the day of receipt, then store the insects on the top shelf of a refrigerator. Do not store the release material more than 36 hours.

A "Shipment Receipt Form" will be included with each shipment of parasites and predators you receive. On this form, you will find the species of the organisms shipped and their origin. You may receive up to three shipments for each release. Each natural enemy species is identified by a unique code that is given in Table 1 on page 26. The first four letters of the code refer to the species and the second two letters refer to the origin (e.g., HvarCS = *Hippodamia variegata* from Santiago, Chile).

Step 3a--Release Predators:

Follow these instructions for releasing predators:

1. Complete the Shipment Receipt Form enclosed with the shipment. Complete the following--Receipt Date, Release Date, State, County, Site, Field. Complete "Condition" Block only when you detect a problem with the container (e.g., crushed or water logged container, large number of dead insects). When possible, count the number of dead in the containers and record in the condition block for the species. Write your name in the box marked "Receiver." Figure 10 shows an example of a completed Shipment Receipt Form for a predator release.

**RWA NATURAL ENEMIES SHIPMENT RECEIPT FORM**

\*\*\*\*\*  
LAB USE ONLY

Shipment Origin  (M=Mission, N=Niles, R=Riverside) Shipment Number

Ship Date  Site Designation Code

\*\*\*\*\*

Receipt Date  Release Date

State  County  Site  Field

\*\*\*\*\*

YEAR	SPECIES	ID CODE	STAGE	#SHIP	#CRTNS	CONDITION
90	HvarCS	PSRF90002	A	2000	7	
91	HvarKD	BIRL91095	A	2500	8	
91	PquaKD	BIRL91096B	A	3500	12	10 DEAD
91	PquaK	BIRL91096A	A	1500	6	
91	LninCY	T91095	A	250	2	
91	LninCW	T91085	A	300	2	
91	LninID	T91066	A	300	3	
91	LninPP	T91056	A	150	1	
91	LninUT	T91083	A	250	2	
91	EnudIF	T91065	A	500	2	2 DEAD
91	EnudKD	T91059A	A	750	3	
90	AmatPN	T90003	M	1000	2	
90	DrapSQ	T90026	M	2500	5	
90	AasyCS	T90116	M	1750	4	
90	AvarUT	T90076	M	2000	4	

SPECIES: See manual for codes  
STAGE: E=EGG / L=LARVA / P=PUPA / A=ADULT / M=MUMMY

\*\*\*\*\*

**Note to Receiver/Releaser:** Complete this form at release (see manual) and mail back to Niles with FDWS and samples. Photocopies of this form may be made for your records and those of your supervisor.

Shipper

Receiver

Figure 10--An Example of a Completed Shipment Receipt Form for Predators

2. Just before taking the cartons into the field, remove the rubber bands, metal bases, and sponges from the cartons.

3. Carrying the container of predators, walk at least 25 paces into the field. Release only one carton of predators at a single location within the field. All successive release points should be spread throughout the field. If you receive 15 cartons of predators for release, release each carton at a separate locations in the field. In large fields (100 acres or larger), narrow the release area down to one quadrant (one quarter section) of the field.

4. Place the carton sideways on the ground.

5. Remove the lid and carefully pull out the paper towelling from the carton.

6. Gently tap the predators out of the carton. Leave the paper towels in the field.

#### Step 3b--Release Parasites:

Most parasites will be shipped as immature insects within parasitized RWA mummies. Parasitized mummies are shipped because the adult parasites are fragile and have a short life span. Parasitized mummy shipments will only be sent to States/areas which already have RWA since a few nonparasitized RWA may be present in shipping containers. State agricultural officials have already been contacted and have approved Courtesy Permits for the parasite shipments.

Follow these procedures for releasing parasites:

1. Complete the Shipment Receipt Form enclosed with the shipment. Complete the following--Receipt Date, Release Date, State, County, Site, Field. Complete "Condition" Block only when you detect a problem with the

\*\*\*\*\* RWA NATURAL ENEMIES SHIPMENT RECEIPT FORM \*\*\*\*\*

LAB USE ONLY

Shipment Origin  (M=Mission,N=Niles,R=Riverside) Shipment Number

Ship Date  Site Designation Code

\*\*\*\*\*

Receipt Date  Release Date

State  County  Site  Field

\*\*\*\*\*

[illegible]

Figure 11--An Example of a Completed Shipment Receipt Form  
for Parasites



2. Carrying the container of parasites, walk at least 25 paces into the field. All successive release points should be equally distributed throughout the field. Do not release any more than one container of parasites at a single site in the field. Parasite and predator release containers should be independently distributed through a field. Do not put parasite and predator release containers at the same locations within a field.

3. Place the container on its side on the ground. Remove the rubber band and two plastic dishes from the ends of the containers. NOTE: Do not remove the screens and do not try to shake the parasites from the container! Leave the carton in the release field. When the adult parasites emerge from the mummies, they will escape through the screens. If parasite adults were shipped to you, release them the same as predator adults.

4. Either retrieve the cartons from the field the next time you visit the field, or leave them in the field (everything except the screens is biodegradable). Please dispose of cartons appropriately, but do not return in the styrofoam shipping container.

Step 4--Complete  
an FDWS

The FDWS is a record of your release and supplies information needed by the State Project Coordinator and the Niles Lab.



FIELD DATA WORK SHEET PLEASE PRINT				FOR LABORATORY USE ONLY			
<p>INSTRUCTIONS: Complete original and one copy of this form. Return the original to the Biological Control Facility, APHIS, USDA, Niles, Michigan 49120. Retain the copy for your file.</p> <p>10. TYPE OF DATA (Check one)</p> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"><input type="checkbox"/> PRE-RELEASE SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> COLLECTION SITE SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> INSECTARY SITE SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> HOST SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> INSECTARY MONITORING</div> <div style="width: 50%;"><input checked="" type="checkbox"/> BIOLOGICAL ORGANISM RELEASE</div> <div style="width: 50%;"><input type="checkbox"/> BIOLOGICAL ORGANISM RECOVERY</div> <div style="width: 50%;"><input type="checkbox"/> OTHER _____</div> </div>				1. SHP. NO.		2. DATE SHPD.	
				3. NO. AND STAGE SHIPPED		4. DATE COLL.	
				5. SPP.		6. ORIGIN	
7. ADJUSTED COUNTS				8. SITE DESIGNATION CODE			
9. SPECIAL INFORMATION				<div style="display: flex; justify-content: space-between;"> <span>NM</span> <span>- Rel</span> </div> <div style="display: flex; justify-content: space-between; font-size: small;"> <span>STATE</span> <span>SITE</span> <span>FIELD</span> <span>SAMPLE NUMBER</span> </div>			
11. STATE NM		12. COUNTY Curry		13. NEAREST TOWN <input type="checkbox"/> TOWNSHIP Melrose		<p>29. MAP OF FIELD AND ITS LOCATION</p> <div style="text-align: center;"> </div>	
14. SECTION OR OTHER DESIGNATION 103° 21' W, 34° 42' N							
15. NAME OF FARMER Tom Turpin		16. PHONE # (217) 781-3468					
17. DATE DATA TAKEN 4-18-91		18. TIME 17:00					
19. CONDITIONS (Check)							
<input checked="" type="checkbox"/> CLEAR <input type="checkbox"/> PT. CLOUDY <input type="checkbox"/> CLOUDY <input type="checkbox"/> RAIN    OTHER (Specify) _____							
20. TEMPERATURE 72°F		21. WIND FROM W AT 4 MPH		22. CROP CONDITION <input checked="" type="checkbox"/> DRY <input type="checkbox"/> DAMP <input type="checkbox"/> WET			
23. CROP CONDITION <input checked="" type="checkbox"/> GOOD <input type="checkbox"/> POOR <input checked="" type="checkbox"/> MIXED		STAND AGE 1 YR.		GROWTH STAGE stem		PLANT HEIGHT _____ IN	
24. INSECT ADULTS		100 SWEEPS <input type="checkbox"/> 200 SWEEPS <input type="checkbox"/>		NUMBER COLLECTED _____		NUMBER SHIPPED _____	
25. INSECT LARVAE		100 SWEEPS <input type="checkbox"/> 200 SWEEPS <input type="checkbox"/>		NUMBER COLLECTED _____		NUMBER SHIPPED _____	
26. OTHER (ORGANISM)		100 SWEEPS <input type="checkbox"/> 200 SWEEPS <input type="checkbox"/>		NUMBER COLLECTED _____		NUMBER SHIPPED _____	
STAGE (Specify) _____		OTHER (SURVEY METHOD) _____		NUMBER COLLECTED _____		NUMBER SHIPPED _____	
27. SURVEY COUNT METHOD				30. CONDITION OF RELEASE MATERIAL			
<input type="checkbox"/> ACTUAL COUNT <input type="checkbox"/> 1/4 QUADRANT X 4 <input type="checkbox"/> OTHER (SPECIFY) _____							
28. PESTICIDE USAGE				31. NUMBER OF DEAD IN RELEASE CONTAINER (ADULT RELEASE ONLY)			
<input checked="" type="checkbox"/> NO <input type="checkbox"/> YES    DATE _____ MATERIAL _____							
33. SURVEYOR'S NAME, TITLE AND TEL. NO. (PLEASE PRINT)				34. DATE SUBMITTED		32. REMARKS (e.g. SEVERE WEATHER, CUTTING DATE, etc.)	
John Dyer (217) 781-2684				4-18-91		Several small areas of RWA damaged plants	

Figure 12--An Example of a Completed FDWS for Release

Follow these instructions to complete the FDWS. Print all information legibly.

Block

<u>Number</u>	<u>Instruction</u>
1-7, 9, 24-27, 30, 31, 33 & 34	Leave blank
8	Fill in State--write two-letter postal designation Site--write "REL" Field--Leave blank Sample number--number of field from the Prerelease survey
10	Check box for "Biological Organism Release"
11-22	Write appropriate information for each item
14	Use longitude and latitude (see NAPIS Reporting Requirements, Appendix 5)
23	Check appropriate box Stand age--For CRP fields, indicate years in CRP. If other than CRP, indicate whether spring or fall planted. Growth stage--write one of the following: Tillering Stem Extension Heading/Flowering Ripening Plant height--leave blank
28	Check "No" unless insecticide has been used

<u>Block Number</u>	<u>Instruction</u>
29	Draw a map of the field with enough detail that someone other than you can find the field. You only need to draw a map during your first release in the field. Include the following: <ul style="list-style-type: none"><li>● Field location in relation to road or highway</li><li>● Easily identifiable landmarks</li><li>● Approximate distance from nearest town</li></ul>
32	Fill in any appropriate remarks.

Use overnight delivery to send the FDWS original, FDWS attachment copies, shipment receipt forms, and mummies to Niles. Distribute FDWS as follows:

- Original--mail to Niles
- Pink copy--mail or deliver to State Project Coordinator
- Yellow copy--keep for your records

Step 5--Mail  
Shipping  
Containers Back  
to Niles, Mission,  
and Riverside  
Labs

All natural enemy shipping containers have pre-addressed, franked return mailing labels inside. Use the return labels to ship containers back to the originating lab as soon as possible. Do not ship the individual paper cartons, petri dishes, etc. back in the styrofoam container--dispose of these items properly.

Step 6--Continue  
Releasing Parasites  
and Predators

You will be making consecutive releases of parasites and predators over a 4 to 6 week period. You will receive multiple shipments of release material every 5 to 10 days. Follow Steps 1 through 5 above for making each release.

See Appendix 5 for reporting release and survey information to NAPIS.





RECOVERY SURVEY  
Introduction

The primary purpose of the Recovery Survey is to obtain qualitative information from 1989, 1990, and 1991 release fields on whether or not any of the exotic, natural enemies have become established. These surveys will also determine the overall impacts that native and established exotic, natural enemies are having on RWA densities in the fields. This survey is a vital part of the RAW biological control project and must be completed exactly as described in the following pages.

The Recovery Survey consists of sampling most 1989, 1990, and 1991 release fields as indicated in Table 2 below. In addition, at least three other fields within 3 miles of the primary field will also be sampled. In some areas, the surrounding fields will also be previous release fields (see Table 2). If a field in which releases were made in previous years is no longer available for surveying, then survey a field as close to the original as possible.

Recovery Surveys will be conducted weekly in each of the previous release areas in each State. The primary and any other previous release fields in the area should be sampled each week, but nonrelease fields may be changed from one week to the next.

Table 2--List of 1989, 1990, and 1991 Release Fields for Identifying 1992 Recovery and Evaluation Surveys

State:	Primary field:	County:	Comment/Instruction:
AZ	90.01	Greenlee	Include Cochise County fields (89.01 and 89.02) in Recovery Survey
CA	91.05	San Joaquin	Include San Joaquin fields 88.04, 88.05, 90.01, 91.03, 91.04, and 91.05 in this Recovery Survey. Sample the primary field 91.05 for evaluation. Due to large number of releases in county, increase fields to be sampled to a minimum of eight per week.

Table 2--List of 1989, 1990, and 1991 Release Fields for  
Identifying 1992 Recovery and Evaluation Surveys  
(Continued)

State:	Primary field:	County:	Comment/Instruction:
CO	89.01	Mesa	Normal recovery (releases performed by State personnel).
CO	90.01	Arapahoe	Normal recovery survey with the primary field sampled for evaluation.
ID	98.01	Power	Normal recovery survey--need to coordinate with Experiment Farm Director.
KS	89.01	Wallace	Normal recovery survey.
KS	91.01	Butler	Normal recovery survey.
KS	90.01	Ness	Normal recovery with the primary field sampled for evaluation.
MT	90.01	Yellowstone	Include Yellowstone county fields 89.03 and 89.04 in recovery survey. Use the primary field for evaluation.
NE	90.01	Banner	Normal recovery survey centered on 90.01 but include Banner county field 89.01 in survey. Do not sample release fields 89.02, 90.02, and 90.03.
NM	90.01	Curry and Quay	Include 89.01 and 89.02 in recovery survey. Primary field sampled for evaluation.
NV	90.01	Churchill	Normal recovery survey.
OK	90.01	Beckham	Normal recovery survey.
OR	90.01	Umatilla	Normal recovery survey.
SD	90.01	Fall River	Normal recovery survey.

Table 2--List of 1989, 1990, and 1991 Release Fields for  
Identifying 1992 Recovery and Evaluation Surveys  
(Continued)

State:	Primary field:	County:	Comment/Instruction:
TX	90.03	Runnels	Normal recovery survey.
TX	91.01	Castro	Include Deaf Smith county fields 87.01 and 91.02 (J. Michels) in recovery survey. Primary field to be sampled for evaluation.
UT	90.01	Utah	Normal recovery survey.
WA	91.01	Garfield	Normal recovery survey. Include other Garfield release fields 89.05, 89.06, 89.07, and 89.08 in the survey. Minimum number of fields sampled increased to eight per week.
WA	91.04	Walla Walla	Include Walla Walla county fields 88.02, 89.13, 89.14, 90.01, 90.02, and 92.03 in recover survey. Primary field to be sampled for evaluation. NOTE: Release fields in Adams (89.01), Douglas (89.04), Grant (89.09, King (88.01), Lincoln (89.10), Spokane (91.02), and Yakima (88.03) are not to be sampled this year--one of these sites may be chosen for 1992 releases.
WY	91.01	Goshen	Normal recovery survey. Include fields 89.01 and 89.02 in survey.
WY	89.03	Laramie	Normal recovery survey. Primary field to be sampled for evaluation. NOTE: Release field in Platte (88.01 and 88.02) are not to be sampled this year--one of these sites may be chosen for 1992 releases.



RECOVERY SURVEY  
Methods and Procedures

Overview

Here is an overview of the steps involved in recovery surveys conducted in 1989, 1990, and 1991 RWA release fields:

Step 1--Locate the previous release sites or areas

Step 2--Determine when to sample

Step 3--Sample Fields and Record Data

3a--Determine tiller infestation rate

3b--Conduct timed searches for parasitized aphids

3c--Take sweep samples for aphid predators

Step 4--Complete an FDWS and Attachment

Step 5--Complete sample labels and mail samples to Niles

Step 6--Continue the survey

Equipment Needed

Most equipment needed will be supplied by the Niles Lab. The RWA survey packs will be sent to you in advance of the survey season. See Appendix 7 for a list of the contents.

Sweepnets and sweepnet replacement bags, hand lenses, and scissors will not be supplied by the Niles Lab. See your State Project Coordinator for these supplies or refer to Appendix 1 for a supply source.

Step 1--Locate the  
Previous Release  
Sites and Other  
Fields to Sample

On a map, locate the release site(s) that has been assigned to you. The release site numbers are indicated for all fields in materials sent to the State Project Coordinator prior to the field season (see Appendix 6 also.) If the previous release field is no longer available, then survey an adjacent field.

At least three other small grain fields (barley or wheat) within a 3 mile radius of the original field must also be located for weekly sampling. In some areas these surrounding fields are also previous release fields (see Table 2). The State Project Coordinator should help identify surrounding fields by the same criteria as release fields.

Locate fields to survey during late winter or early spring. The best situation is to choose a wheat or barley field for release but with an adjacent CRP field. Spring planted fields are preferable to winter wheat. Inform the county Agricultural Extension agent(s) of the project and ask for possible field locations, especially farmers who do not use insecticides. Ask the agent if there are any organic farms in the area.

Use the following criteria for selecting fields:

- Wheat or barley fields with adjacent CRP fields are preferred
- Spring planted fields are preferred over winter wheat fields
- No insecticides used in fields for past 3 months
- RWA present in field or vicinity during previous years
- Surrounding areas contain both disturbed and undisturbed vegetation (e.g. wild grasses, brush lots, wooded areas, weedy fields, roadsides)
- Near other crops that harbor aphids throughout the season--sorghum, alfalfa, clover, corn, sugar sugar beets, potatoes

Once you have located a potential field, get the farmer's/landowner's permission to sample the field.

Step 2--Determine  
When to Sample

Do not begin recovery samples in any field until at least 4 percent of the tillers are infested. Preliminary samples of selected fields should begin when fall planted crops (e.g., winter wheat) begin spring growth. For spring planted crops, start preliminary sampling once stem extension begins. To perform a preliminary sample, examine at least 50 randomly selected tillers in each field to determine percent of infestations (see Prerelease Survey instructions).

Recovery surveys will be repeated weekly at each site until the small grain crops in the area matures and dries down.

Step 3--Sample  
Fields and  
Record Data

In each of three separate areas of each field, obtain the following data:

Step 3a--Determine Tiller Infestation Rate:

1. Walk at least 15 paces into the field.
2. Randomly select a nearby tiller and gently cut it at its base. In CRP fields, select only tillers from grain plants in the field. Examine the entire tiller closely for the presence of aphids. Tally the number of infested and noninfested tillers examined in Block 36 of the FDWS Attachment. For tillers with aphids, if species of aphids other than RWA are present, then keep track of these tillers separately from those with RWA present.
3. Walk at least 10 paces in any direction and repeat 1 and 2 above until you've examined 50 tillers in the area. Take tillers from as many diverse areas in the field as possible.
4. Repeat 1 to 3 above in the other two areas of the field. On each sampling date, new areas in the field should be selected for sampling.

Step 3b--Conduct Timed Searches for Parasitized Aphids:

1. Return to the field and walk in at least 15 paces from the edge.
2. With a wristwatch, note the time and then begin searching for mummified aphids in the field. Search all areas of the plant including the base and grain head. Some aphids parasitized by certain species of parasites may wander from the original plant, so check weeds, sticks, rocks, etc., as well as the grain plants. Continue to search for a total of 15 minutes in the area--note that if three people are searching the area, then each would search for 5 minutes to obtain a total of 15 minutes of effort.
3. When conducting the search, collect all the mummies. Do not detach a mummy from the substrate to which it is attached--collect the mummies with a piece of the attached plant material or other substrate.
4. When the timed search in the area is completed, take the mummies back to the vehicle and begin processing them. With a pair of small scissors, gently cut any extra plant material or other substrate away from the attachment location of the mummy. Place each mummy with a small piece of the attached substrate into a capsule and close the capsule with the attached cap. Place only a single mummy in a capsule. Do not jam the capsule full of extraneous plant material--it will crush the mummy. Place only a single mummy into a single capsule. Place all the mummies found in an area into a resealable plastic bag (one bag per area).
5. Record the number of mummies found in each area in the appropriate location in Block 37 of the FDWS Attachment.
6. Repeat 1 to 5 above in each of the other two areas of the field.



Step 3c--Take Sweep Samples for Aphid Predators:

1. Walk at least 15 paces into the field from the edge.
2. Take 100 sweeps with the sweepnet.
3. Walk back to your vehicle. Dump the contents of the sweepnet into a sorting pan and remove plant parts, large insects such as grasshoppers, crickets, bees, and wasps from the samples. Place all the remaining insects from the sweep sample into 4 oz. jars with alcohol. Note that samples from each area of the field will be placed in separate jars.
4. Repeat 1 to 3 above in each of the other two areas of the field.

Step 4--Complete  
an FDWS and  
Attachment

The FDWS is a record of your survey and supplies information needed by the State Project Coordinator and the Niles Lab.

FIELD DATA WORK SHEET PLEASE PRINT				FOR LABORATORY USE ONLY			
INSTRUCTIONS: Complete original and one copy of this form. Return the original to the Biological Control Facility, APHIS, USDA, Niles, Michigan 49120. Retain the copy for your file.				1. SHP. NO.	2. DATE SHPD	3. NO. AND STAGE SHIPPED	4. DATE COLL.
				5. SPP			6. ORIGIN
10. TYPE OF DATA (Check one)				7. ADJUSTED COUNTS		8. SITE DESIGNATION CODE	
<input type="checkbox"/> PRE RELEASE SURVEY <input type="checkbox"/> COLLECTION SITE SURVEY <input type="checkbox"/> INSECTARY SITE SURVEY <input type="checkbox"/> HOST SURVEY <input type="checkbox"/> INSECTARY MONITORING <input type="checkbox"/> BIOLOGICAL ORGANISM RELEASE <input checked="" type="checkbox"/> BIOLOGICAL ORGANISM RECOVERY <input type="checkbox"/> OTHER _____				9. SPECIAL INFORMATION		UT - UT99.01 - 4 - STATE      SITE      FIELD      SAMPLE NUMBER	
11. STATE UT	12. COUNTY Summit	13. <input checked="" type="checkbox"/> NEAREST TOWN <input type="checkbox"/> TOWNSHIP Coalville		29. MAP OF FIELD AND ITS LOCATION			
14. SECTION OR OTHER DESIGNATION 111° 16' W, 40° 53' N				15. CROP ACRES			
16. NAME OF FARMER Jerry Pulaski		PHONE # (801) 353-8123		17. DATE DATA TAKEN 4-2-91	18. TIME 1:00 <small>a.m.</small>		
19. CONDITIONS (Check)							
<input type="checkbox"/> CLEAR <input checked="" type="checkbox"/> PT. CLOUDY <input type="checkbox"/> CLOUDY <input type="checkbox"/> RAIN    OTHER (Specify) _____							
20. TEMPERATURE 68°F		21. WIND FROM W AT 2 MPH		22. CROP CONDITION <input type="checkbox"/> DRY <input checked="" type="checkbox"/> DAMP <input type="checkbox"/> WET			
23. CROP CONDITION <input checked="" type="checkbox"/> GOOD <input checked="" type="checkbox"/> POOR <input type="checkbox"/> MIXED		STAND AGE <u>full</u> YR		GROWTH <u>Stem</u> STAGE <u>exten.</u>		PLANT HEIGHT _____ IN	
24. INSECT ADULTS		<input type="checkbox"/> 100 SWEEPS <input type="checkbox"/> 200 SWEEPS		NUMBER COLLECTED _____		NUMBER SHIPPED _____	
25. INSECT LARVAE		<input type="checkbox"/> 100 SWEEPS <input type="checkbox"/> 200 SWEEPS		NUMBER COLLECTED _____		NUMBER SHIPPED _____	
26. OTHER (ORGANISM) STAGE		<input type="checkbox"/> 100 SWEEPS <input type="checkbox"/> 200 SWEEPS		NUMBER COLLECTED _____		NUMBER SHIPPED _____	
27. SURVEY COUNT METHOD							
<input type="checkbox"/> ACTUAL COUNT <input type="checkbox"/> 1/4 QUADRANT X 4 <input type="checkbox"/> OTHER (SPECIFY) _____							
28. PESTICIDE USAGE							
<input checked="" type="checkbox"/> NO <input type="checkbox"/> YES    DATE _____ MATERIAL _____ <input type="checkbox"/> GROUND <input type="checkbox"/> AIR							
33. SURVEYOR'S NAME, TITLE AND TEL. NO. (PLEASE PRINT) Jim Jones (801) 353-5616				34. DATE SUBMITTED 4-2-91		32. REMARKS (i.e. SEVERE WEATHER, CUTTING DATE, etc.) High RWA damage, many lady beetles	
30. CONDITION OF RELEASE MATERIAL							
31. NUMBER OF DEAD IN RELEASE CONTAINER (ADULT RELEASE ONLY)							

Figure 13--An Example of a Completed FDWS for the Recovery Survey



Follow these instructions to complete the FDWS. Complete a separate FDWS for each field sampled.

<u>Block Number</u>	<u>Instruction</u>
1-7,9, 24-27, 30 & 31	Leave blank
8	Fill in State--two-letter postal designation Site--fill in Primary Release Site Number from Table 2 Field--number of field in area (Primary field is 0) Sample number--leave blank
10	Check box for "Biological Organism Recovery."
11-22	Write appropriate information for each item
14	Use longitude and latitude
23	Check appropriate box Stand age--For CRP fields, indicate years as CRP land. If other than CRP, indicate whether field was fall or spring planted. Growth stage--write one of the following: Tillering Stem Extension Heading/Flowering Ripening Plant height--leave blank
28	Check "no" unless an insecticide was used



<u>Block Number</u>	<u>Instruction</u>
29	<p>Draw a map of the field with enough detail that someone other than you can find the field. You only need to draw a map during your first visit to the field. For fields other than the release field, show the relation (direction, distance) to the original or primary release field. When drawing, include:</p> <ul style="list-style-type: none"><li>● Approximate distance and direction from the release site</li><li>● Field location in relation to road or highway</li><li>● Easily identifiable landmarks</li><li>● Approximate distance from nearest town</li></ul>
32	<p>Fill in any appropriate remarks. Note severe weather conditions.</p>

FDWS ATTACHMENT - RWA SAMPLING FORM

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35. SITE DESIGNATION CODE      UT   -   89.01   -   2   -   4-2-92

STATE                      SITE                      FIELD                      DATE DATA TAKEN

---

36. TILLER INFESTATION RATE

	AREA 1	AREA 2	AREA 3	TOTAL
APHIDS ABSENT				88
APHIDS PRESENT				49
- RWA + OTHERS				
- OTHERS ONLY	1		0	13

\*\*\* FOR INTENSE EVALUATION FIELDS ONLY:

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF RWA INFESTED TILLERS SENT				

---

37. PARASITE ABUNDANCE - TIMED SEARCH

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF MUMMIES FOUND	7	1	23	31

LAB USE ONLY	AREA 1	AREA 2	AREA 3	TOTAL
# SPECIMENS RCVD				
# MUMMIES				
- # VIABLE				
- # NOT VIABLE				

---

38. PREDATOR ABUNDANCE - SWEEP NET SAMPLES

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF SWEEPS	100	100	100	300

Figure 14--An Example of a Completed FDWS Attachment for the Recovery Survey

<u>Block number</u>	<u>Instruction</u>
35	Fill in same as Block 8 on FDWS. Indicate sample date.
36	Tally the numbers of tillers infested by RWA separately from those tillers infested by other aphids (no RWA present). Tally marks must be recorded separately for each of the three areas of the field.
37	Indicate the number of mummies found during the 15 minute search in each of the three areas of the field.
38	Indicate the number of sweeps taken in each of the three areas of the field.

Distribute the FDWS original and copies as follows (include a copy of the Attachment with each copy of the FDWS--photocopy the Attachment for distribution):

- Original--mail to Niles Lab. The original copies should be included in the shipping tube containing the three bags of mummies (to be shipped by overnight delivery to Niles).
- Pink copy--mail or deliver to the State Project Coordinator
- Yellow copy--keep for your records

Step 5--Complete  
Sample Labels and  
Mail Samples to  
Niles

The accurate completion of labels and mailing/shipping are essential parts of the field work. Please pay special attention to properly completing the following items.

Use a pencil to complete all labels. Ink will dissolve in alcohol, thus making the enclosed specimens worthless. Print all information legibly.

### Resealable Plastic Bags of Mummies:

On the white area on the exterior of the bag, write with a pencil the site code (e.g., UT89.01), the sample date, and the area of the field from which the mummies in the bag came from (e.g., 1, 2, or 3).

Place the three bags of mummies into a shipping tube with the original FDWS, FDWS Attachment. Ship these mummies and forms to the Niles Lab by overnight or next-day delivery service (Express Mail, Airborne Express, UPS, Federal Express, etc.). Pre-addressed labels are included in your equipment packages. Ship the mummy samples within 12 hours after sampling the field.

### Jars from Sweep Net Samples:

SAMPLE LABEL	
(1) SURVEY	<u>Sweep Recovery</u>
(2) STATE <u>UT</u>	COUNTY <u>Summit</u> (3)
(4) SITE <u>UT89.01</u>	FIELD <u>Area 2</u> (5)
(6) DATE	<u>4-2-91</u>
(7) COLLECTOR	<u>Jim Jones</u>

Figure 15--An Example of a Sample Label for Jars From Sweep Net

- (1) Write "Recovery"
- (2) Write two-letter postal abbreviation for State.
- (3) Write county where field is located.
- (4) Write in the primary release site number from Table 2.
- (5) Write the area of the field from which the sample came (e.g., 1, 2, or 3).
- (6) Write the sample date.
- (7) Write your name.

Place a completed sweep sample label into each jar--one jar per area of the field. Make sure the lids of the jars are tightly closed! Place the three jars into a mailing tube and add some wadded paper towelling to reduce movement of the jars. Ship the mailing tube with the pre-addressed, franked mailing labels to the Niles Lab. The tubes should be shipped by regular mail, but get them to the post office within 24 hours after taking the sample.

Step 6--Continue  
the Survey

At least three other fields besides the primary fields must be sampled in each recovery area each week. The surrounding fields should be within 3 miles of the original release field unless indicated otherwise (see Table 2). All fields in an area should be sampled during a single day. All fields are sampled the same way. Separate forms and labels should be filled out and submitted for each field. Plan to continue surveying all fields every week until harvest or until instructed to stop.

If Niles determines anything unusual in your recovery samples, you may be asked to take additional or modified samples. In some cases, Niles personnel and others may visit your fields if samples indicate the establishment of some natural enemy species and the possible suppression of RWA population densities.









## EVALUATION SURVEY

### Introduction

The purpose of the evaluation survey is to obtain detailed information from specific previous release fields in a limited number of States. Evaluation surveys will determine not only the establishment of exotic, natural enemies, but also the impacts that they and native, natural enemies are having on RWA densities in fields. This survey is a vital part of the RWA Biological Control Project and must be completed exactly as described in the following pages. The same sampling techniques must be used consistently in each field so valid comparisons can be made among fields in different regions and States. The results of this survey will be used to make major decisions about the future directions and techniques of the RWA Project. For example, results from the evaluation survey, coupled with recovery survey results, will be used to determine if redistribution efforts for specific natural enemy species that become established should begin and at what intensity. In addition, the results may answer the question on how many redistribution sites are required per area relative to the dispersal and establishment time characteristics of an established, exotic, natural enemy species. Results from this survey will also be used by economists to determine the monetary benefits of the RWA Project when natural enemies become established.

Evaluation surveys will be conducted only in a single field in each of the following States:

California	New Mexico
Colorado	Texas
Kansas	Washington
Montana	Wyoming

Evaluation fields (identified in Table 2, page 55) are always the primary fields within areas identified for recovery surveys in these States. Since evaluation surveys are very similar to recovery surveys except that a greater number of samples are required, the evaluation survey replaces the recovery survey in the primary field. At least three surrounding fields in the recovery area must be sampled weekly with the techniques described in the recovery survey section of this manual. Evaluation surveys will also be conducted weekly throughout the growing season.



In addition to the following instructions, some special instructions may be supplied to you by the Niles Laboratory (for example, special instructions will explain how to obtain information or data on yields in the evaluation fields). Other types of information may also be requested.

EVALUATION SURVEY  
Methods and Procedures

Overview

Here is an overview of the steps involved in evaluation surveys conducted in specific RWA release fields:

Step 1--Locate the release site

Step 2--Determine when to sample

Step 3--Sample Field and Record Data

3a--Determine tiller infestation rate

3b--Conduct timed searches for parasitized aphids

3c--Take sweep samples for aphid predators

Step 4--Complete an FDWS and Attachment

Step 5--Complete sample labels and mail samples to Niles

Step 6--Continue the survey

Equipment Needed

Most equipment needed will be supplied by the Niles Lab. The RWA survey packs will be sent to you in advance of the survey season. See Appendix 7 for a list of the contents.

Sweepnets and sweepnet replacement bags, hand lenses, and scissors will not be supplied by the Niles Lab. See your State Project Coordinator for these supplies or refer to Appendix 1 for a supply source.

Step 1--Locate the  
Release Site

On a map, locate the release site(s) that has been assigned to you. The release site numbers are indicated for all fields in materials sent to the State Project Coordinator prior to the field season (see Appendix 6 also.) If the previous release field is no longer available, then survey an adjacent field.



Step 2--Determine  
When to Sample

Do not begin evaluation samples until at least 4 percent of the tillers are infested. Begin preliminary tiller sampling when fall planted crops (i.e., winter wheat) begin spring growth. For spring planted crops, start sampling once stem extension begins. Surveys will be conducted weekly.

Step 3--Sample  
Fields and  
Record Data

In each of three separate areas of the field, obtain the following data:

Step 3a--Determine Tiller Infestation Rate:

1. Walk at least 15 paces into the field.
2. Randomly select a nearby tiller and gently cut it at its base. In CRP fields, select only tillers from grain plants in the field. Examine the entire tiller closely for the presence of aphids. Tally the number of infested and noninfested tillers examined in Block 36 of the FDWS Attachment. For tillers with aphids, if species of aphids other than RWA are present, then keep track of these tillers separately from those with RWA present.
3. Walk at least 10 paces in any direction and repeat 1 and 2 above until you've examined 75 tillers in the area. Take tillers from as many diverse areas in the field as possible.
4. In each area of the field, place the first 10 RWA infested tillers you find into individual plastic bags (note that there may be fewer than eight infested tillers per area when field infestation rates are low). After completing the tiller sampling in the area, return to the vehicle and process the individual RWA infested tillers. Gently detach each infested leaf on each tiller and place all infested leaves from a tiller into an individual 4 oz. container of alcohol. Do not bend the rolled leaves. Gently curl the leaves into the container with as little deformation as possible. Use separate containers for each tiller. Indicate the number of infested tillers ( = containers) that you processed in each area of the field.

5. Repeat 1 to 4 above in the other two areas of the field. On each sampling date, new areas in the field should be selected for sampling.

Step 3b--Conduct Timed Searches for Parasitized Aphids:

1. Return to the field and walk in at least 15 paces from the edge.

2. With a wristwatch, note the time and then begin searching for mummified aphids in the field. Search all areas of the plant including the base and grain head. Some aphids parasitized by certain species of parasites may wander from the original plant, so check weeds, sticks, rocks, etc., as well as the grain plants. Continue to search for a total of 20 minutes in the area--note that if two people are searching the area, then each would search for 10 minutes to obtain a total of 20 minutes of effort.

3. When conducting the search, collect all the mummies. Do not detach a mummy from the substrate to which it is attached--collect the mummies with a piece of the attached plant material or other substrate.

4. When the timed search in the area is completed, take the mummies back to the vehicle and begin processing them. With a pair of small scissors, gently cut any extra plant material or other substrate away from the attachment location of the mummy. Place each mummy with a small piece of the attached substrate into a capsule and close the capsule with the attached cap. Place only a single mummy in a capsule. Do not jam the capsule full of extraneous plant material--it will crush the mummy. Place only a single mummy into a single capsule. Place all the mummies found in an area into a resealable plastic bag (one bag per area).

5. Record the number of mummies found in each area in the appropriate location in Block 37 of the FDWS Attachment.

6. Repeat 1 to 5 above in each of the other two areas of the field.

Step 3c--Take Sweep Samples for Aphid Predators:

1. Walk at least 15 paces into the field from the edges.
2. Take 150 sweeps with the sweepnet.
3. Walk back to your vehicle. Dump the contents of the sweepnet into a sorting pan and remove all plant parts, large insects such as grasshoppers, crickets, bees, and wasps from the samples. Place all the remaining insects from the sweep sample into 4 oz. jars with alcohol. Note that samples from each area of the field will be placed in separate jars.
4. Repeat 1 to 3 above in each of the other two areas of the field.

Step 4--Complete  
an FDWS and  
Attachment

The FDWS is a record of your survey and supplies information needed by the State Project Coordinator and the Niles Lab.

FIELD DATA WORK SHEET PLEASE PRINT				FOR LABORATORY USE ONLY			
<p>INSTRUCTIONS: Complete original and one copy of this form. Return the original to the Biological Control Facility, APHIS, USDA, Niles, Michigan 49120. Retain the copy for your file.</p> <p>10. TYPE OF DATA (Check one)</p> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"><input type="checkbox"/> PRE RELEASE SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> COLLECTION SITE SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> INSECTARY SITE SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> HOST SURVEY</div> <div style="width: 50%;"><input type="checkbox"/> INSECTARY MONITORING</div> <div style="width: 50%;"><input type="checkbox"/> BIOLOGICAL ORGANISM RELEASE</div> <div style="width: 50%;"><input type="checkbox"/> BIOLOGICAL ORGANISM RECOVERY</div> <div style="width: 50%;"><input checked="" type="checkbox"/> OTHER <u>Evaluation</u></div> </div>				1. SHIP NO.		2. DATE SHIPD	
				3. SPP		4. DATE COLL.	
				7. ADJUSTED COUNTS		8. SITE DESIGNATION CODE	
9. SPECIAL INFORMATION				<u>UT</u> - <u>UT89.01</u> - <u>0</u> - <u>        </u> STATE                      SITE                      FIELD                      SAMPLE NUMBER			
11. STATE <u>UT</u>		12. COUNTY <u>Summit</u>		13. <input checked="" type="checkbox"/> NEAREST TOWN <u>Coalville</u>		14. TOWNSHIP	
14. SECTION OR OTHER DESIGNATION <u>111° 16' W, 40° 53' N</u>				15. CROP ACRES <u>        </u>			
16. NAME OF FARMER <u>Jerry Pulaski</u>		PHONE # <u>(801) 353-8123</u>		17. DATE DATA TAKEN <u>4-2-91</u>		18. TIME <u>1:00</u> <u>P.M.</u>	
19. (CONTINUED) (Check) <input type="checkbox"/> CLEAR <input checked="" type="checkbox"/> PT CLOUDY <input type="checkbox"/> CLOUDY <input type="checkbox"/> RAIN    OTHER (Specify) <u>        </u>							
20. TEMPERATURE <u>68°</u>		21. WIND FROM <u>W</u> AT <u>2</u> MPH		22. CROP CONDITION <input type="checkbox"/> DRY <input checked="" type="checkbox"/> DAMP <input type="checkbox"/> WET			
23. CROP CONDITION <input checked="" type="checkbox"/> GOOD <input checked="" type="checkbox"/> POOR <input type="checkbox"/> MIXED		STAND AGE <u>full</u> YR		GROWTH STAGE <u>Stem</u>		PLANT HEIGHT <u>        </u> IN	
24. INSECT ADULTS <input type="checkbox"/> 100 SWEEPS <input type="checkbox"/> 200 SWEEPS		NUMBER COLLECTED <u>        </u>		NUMBER SHIPPED <u>        </u>			
25. INSECT LARVAE <input type="checkbox"/> 100 SWEEPS <input type="checkbox"/> 200 SWEEPS		NUMBER COLLECTED <u>        </u>		NUMBER SHIPPED <u>        </u>			
26. OTHER ORGANISM STAGE <u>Specimen</u>		NUMBER COLLECTED <u>        </u>		NUMBER SHIPPED <u>        </u>			
27. SURVEY COUNT METHOD <input type="checkbox"/> ACTUAL COUNT <input type="checkbox"/> 1/4 QUADRANT E.C. <input type="checkbox"/> OTHER (SPECIFY) <u>        </u>							
28. PESTICIDE USAGE <input checked="" type="checkbox"/> NO <input type="checkbox"/> YES    DATE <u>        </u> MATERIAL <u>        </u> <input type="checkbox"/> GROUND <input type="checkbox"/> AIR							
29. SURVEYOR'S NAME, TITLE AND TEL. NO. (PLEASE PRINT) <u>Jim Jones (801) 353-5616</u>				30. DATE SUBMITTED <u>4-2-91</u>		31. REMARKS (e.g. SEVERE WEATHER, CUTTING DATE, etc.) <u>High RWA damage, many lady beetles</u>	

MAP REQUIRED FOR FIRST VISIT ONLY - UNLESS RELEASES MADE.

U.S. GOVERNMENT PRINTING OFFICE 1988-643-863

Figure 16--An Example of a Completed FDWS for the Evaluation Survey

Follow these instructions to complete the FDWS. Complete a separate FDWS for each field sampled.

<u>Block Number</u>	<u>Instruction</u>
1-7,9, 24-27, 30 & 31	Leave blank
8	Fill in State--two-letter postal designation Site--fill in Release Site Number from Table 2 Field--number of field = 0 Sample number--leave blank
10	Check box for "Other" and write "Evaluation."
11-22	Write appropriate information for each item
14	Use longitude and latitude
23	Check appropriate box Stand age--For CRP fields, indicate years as CRP land. If other than CRP, indicate whether field was fall or spring planted. Growth stage--write one of the following: Tillering Stem Extension Heading/Flowering Ripening Plant height--leave blank
28	Check "no" unless an insecticide was used



<u>Block Number</u>	<u>Instruction</u>
29	<p>Draw a map of the field with enough detail that someone other than you can find the field. You only need to draw a map during your first visit to the field. For fields other than the release field, show the relation (direction, distance) to the original release field. When drawing, include:</p> <ul style="list-style-type: none"><li>● Field location in relation to road or highway</li><li>● Easily identifiable landmarks</li><li>● Approximate distance from nearest town</li></ul>
32	<p>Fill in any appropriate remarks. Note severe weather conditions.</p>



FDWS ATTACHMENT - RWA SAMPLING FORM

\*\*\*\*\*

35. SITE DESIGNATION CODE      UT      -      8901      -      0      -      4-2-92

STATE                      SITE                      FIELD                      DATE DATA TAKEN

\*\*\*\*\*

36. TILLER INFESTATION RATE

	AREA 1	AREA 2	AREA 3	TOTAL
APHIDS ABSENT	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	170
APHIDS PRESENT - RWA + OTHERS	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	45
- OTHERS ONLY	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	<del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del> <del>     </del>	10

\*\*\* FOR INTENSE EVALUATION FIELDS ONLY:

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF RWA INFESTED TILLERS SENT	10	8	10	28

\*\*\*\*\*

37. PARASITE ABUNDANCE - TIMED SEARCH

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF MUMMIES FOUND	14	3	38	55

LAB USE ONLY	AREA 1	AREA 2	AREA 3	TOTAL
# SPECIMENS RCVD				
# MUMMIES				
- # VIABLE				
- # NOT VIABLE				

\*\*\*\*\*

38. PREDATOR ABUNDANCE - SWEEP NET SAMPLES

	AREA 1	AREA 2	AREA 3	TOTAL
NUMBER OF SWEEPS	150	150	150	450

Figure 17--An Example of a Completed FDWS Attachment for  
the Evaluation Survey

<u>Block number</u>	<u>Instruction</u>
35	Fill in same as Block 8 on FDWS. Indicate sample date.
36	<p>Tally the numbers of tillers infested by RWA separately from those tillers infested by other aphids (no RWA present). Tally marks must be recorded separately for each of the three areas of the field.</p> <p>Indicate the number of RWA infested tillers processed in each area of the field. Note that there should be a jar associated with each infested tiller.</p>
37	Indicate the number of mummies found during the 20 minute search in each of the three areas of the field.
38	Indicate the number of sweeps taken in each of the three areas of the field.

Distribute the FDWS original and copies as follows (include a copy of the Attachment with each copy of the FDWS--photocopy the Attachment for distribution):

- Original--mail to Niles Lab. The original copies should be included in the shipping tube containing the three bags of mummies (to be shipped by overnight delivery to Niles).
- Pink copy--mail or deliver to the State Project Coordinator
- Yellow copy--keep for your records

Step 5--Complete  
Sample Labels and  
Mail Samples to  
Niles

The accurate completion of labels and mailing/shipping are essential parts of the field work. Please pay special attention to properly completing the following items.

Use a pencil to complete all labels. Ink will dissolve in alcohol, thus making the enclosed specimens worthless. Print all information legibly.

Resealable Plastic Bags of Mummies:

On the white area on the exterior of the bag, write with a pencil the site code (e.g., UT89.01), the sample date, and the area of the field from which the mummies in the bag came from (e.g., 1, 2, or 3).

Place the three bags of mummies into a shipping tube with the original FDWS, FDWS Attachment, and all Shipment Receipt Forms (in a release field). Ship these mummies and forms to the Niles Lab by overnight or next-day delivery service (Express Mail, Airborne Express, UPS, Federal Express, etc.). Pre-addressed labels are included in your equipment packages. Ship the mummy samples within 12 hours after sampling the field.

Jars from Sweep Net Samples:

SAMPLE LABEL	
(1)	SURVEY <u>Sweep Eval</u>
(2)	STATE <u>UT</u> COUNTY <u>Summit</u> (3)
(4)	SITE <u>UT89.01</u> FIELD <u>Area 2</u> (5)
(6)	DATE <u>4-2-91</u>
(7)	COLLECTOR <u>Jim Jones</u>

Figure 18--An Example of a Sample Label for Jars From Sweep Net

- (1) Write "Sweep-Eval"
- (2) Write two-letter postal abbreviation for State.
- (3) Write county where field is located.
- (4) Write in the release site number.

(5) Write the area of the field from which the sample came (e.g., 1, 2, or 3).

(6) Write the sample date.

(7) Write your name.

Place a completed sweep sample label into each jar--one jar per area of the field. Make sure the lids of the jars are tightly closed! Place the three jars into a mailing tube and add some wadded paper towelling to reduce movement of the jars. Ship the mailing tube with the pre-addressed, franked mailing labels to the Niles Lab. The tubes should be shipped by regular mail, but get them to the post office within 24 hours after taking the sample.

Jars of Leaves From Infested Tillers--Intense Survey Fields Only:

SAMPLE LABEL	
(1) SURVEY	<u>Tiller - Eval</u>
(2) STATE <u>UT</u>	COUNTY <u>Summit</u> (3)
(4) SITE <u>UT89.01</u>	FIELD <u>Area 1</u> (5)
(6) DATE	<u>4-2-91</u>
(7) COLLECTOR	<u>Jim Jones</u>

Figure 19--An Example of a Sample Label for Jars of Leaves From Infested Tillers

(1) Write "Tiller-Eval"

(2) Write two-letter postal abbreviation for State.

(3) Write county where field is located.

(4) Write in the release site number.

(5) Write the area of the field from which the tiller came (e.g., 1, 2, or 3).

(6) Write the sample date.

(7) Write your name.

Place a completed tiller sample label into each jar--one jar per tiller and as many as 24 jars per field. Make sure the lids of the jars are tightly closed! Place the jars back into the box in which they came in. Add some wadded paper towelling to reduce movement of the jars. Ship to the Niles Lab. The boxes should be shipped by regular mail, but get them to the post office within 24 hours after taking the sample.

Step 6--Continue  
the Survey

Plan to continue surveying all fields every week until harvest or until instructed to stop.

If Niles determines anything unusual in your evaluation samples you may be asked to take additional or modified samples. In some cases, Niles personnel and others may visit your fields if samples indicate the establishment of some natural enemy species and the possible suppression of RWA population densities.







APPENDIX 1--SOURCES FOR EQUIPMENT NOT SUPPLIED BY NILES  
LAB

Sweepnets, sweepnet replacement bags, and hand lenses may be purchased from most biological supply companies. Two sources for these supplies are--

WARDS  
5100 West Henrietta Road  
P.O. Box 92912  
Rochester, NY 14692-9012

Telephone number (800) 962-2660

Heavy duty beating net and frame (Catalog Number  
10 W 0560)--\$25.10

Replacement nets (for sweepnet) (Catalog Number  
10 W 0565)--\$9.85

Hand lens 10X magnifier (Catalog Number 25 W  
1400)--\$4.35

Bio Quip  
17803 La Salle Avenue  
Gardena, CA 90248

Telephone number (213) 324-0620

Heavy duty sweepnet with bag (Catalog number  
7625HS)--\$14.95

Replacement bag (for sweepnet) (Catalog number  
7215HS)--\$8.30

Hand lens 10X magnifier (Catalog Number  
1129A)--\$4.90







APPENDIX 2--CRITERIA TO BE USED BY STATE PROJECT  
COORDINATORS FOR SELECTING RELEASE AREAS

The State Project Coordinator is responsible for selecting an area in the State where releases will occur. The purpose is to define an area which is most likely to have fields and an environment to support the establishment of exotic parasites and predators of the Russian wheat aphid (RWA). Consult with county and State agricultural agents, grower organizations, university researchers, and other individuals who possess a working knowledge of cropping practices, pesticide use, and aphid problems in specific areas of the State prior to selecting a release area. Be sure to select the area no later than late winter. Use the following criteria in selecting an area:

- RWA host crops\* should be common in the area. Both fall and spring sown crops should be present as well as Conservation Reserve Program (CRP) fields with RWA susceptible plants. See Appendix 10 for list of known hosts of RWA.
- An area where RWA has been present for several years should be selected over areas where RWA has just been detected. Also the area should be experiencing economic damage from RWA.
- Little or no pesticide usage in the area. Areas that are subjected to areawide applications of insecticides (e.g., grasshopper control areas) should be avoided. Areas with organic farms are ideal.
- Field size--area to be considered for release should contain fields with a minimum size of 40 acres.
- Noncultivated crops are nearby (CRP land, weedy fields, fence post rows, roadside grasslands).
- Mix of annual and perennial crops (alfalfa, clover, fruit trees mixed with small grains--wheat, barley oats).

\*Preferred field types for release of RWA natural enemies are (in order of preference)--

1. Spring wheat or barley with adjacent CRP land
2. Winter wheat with adjacent CRP land
3. CRP land with small grains
4. Oats
5. Other small grains









APPENDIX 3--CRITERIA TO BE USED WHEN DROPPING FIELDS FROM  
THE PRERELEASE SURVEY

The State Project Coordinator should use the following criteria when dropping fields from the Prerelease Survey.

NOTE: Only the State Project Coordinator is authorized to drop fields from the survey.

1. Field has been or will be treated with an insecticide.
2. There are none or too few aphids in the field relative to other fields being sampled.
3. Unwillingness of the farmer/landowner to abide by conditions for releasing parasites and predators.
4. Russian wheat aphid is too abundant in the field. When extensive damage occurs, the likelihood of treatment (insecticide usage) is high. Such fields are not good candidates for release. Immediately notify the farmer/landowner when you drop the field from consideration.
5. Absence of native coccinellid adults and/or larvae in field, which indicates unsuitable conditions (insufficient aphids, insecticides present, etc.) for reproduction of species to be released.

Remaining fields in survey will continue to be sampled weekly until the final release field is selected and time for release is determined.







APPENDIX 4--CRITERIA TO BE USED BY THE STATE PROJECT  
COORDINATOR FOR SELECTING RELEASE FIELDS

The State Project Coordinator, in consultation with the Niles Lab, will select the one field in the area to receive parasite and predator releases. Selection of the release field will be based on prerelease survey data and the following criteria:

1. Survey data indicate that samples have shown continually increasing densities of aphids in the fields and the current density of aphids is at least 4 percent infested tillers. Fields with moderate densities should be selected over fields with high densities.
2. The areas surrounding the release field should contain a mixture of disturbed (cultivated) and undisturbed (uncultivated or native) areas. There should be some perennial crops close to the field, such as alfalfa and clover or Conservation Reserve Program (CRP) fields.
3. Farmer's/landowner's understanding and support of biological control, and a willingness to abide by the conditions for release.
4. Field is a minimum of 40 acres in size.

The State Project Coordinator will consult with the Niles Lab in selecting a field to receive releases.









## APPENDIX 5--REPORTING INFORMATION INTO THE NATIONAL AGRICULTURAL PEST INFORMATION SYSTEM (NAPIS)

These instructions cover how to report Recovery and Evaluation Survey results and releases of exotic aphid parasites and predators into the NAPIS database. All release, recovery, and evaluation information must be entered into NAPIS. Questions on entering information should be directed to your State CAPS coordinator or PPQ Regional Survey Coordinator.

With many States entering data on the same program, it is important that each State uses the proper codes and enters all the required data. Figures 5-1 and 5-3 are examples of worksheets that can be used to summarize data from the Field Data Worksheet for reporting data into NAPIS. Use of these worksheets should decrease the time for data entry and reduce errors. By following the data entry requirements covered in this Appendix (Figures 5-2 and 5-4), data quality will be ensured. Information access across State boundaries will be consistent. Ad hoc queries, reports, and computer mapping depend on all the proper codes being entered.

When reporting information from Recovery and Evaluation Surveys, all identifications must be confirmed by Niles before entering the species information into NAPIS. You should enter information into NAPIS immediately after sampling, but enter "unknown" for species until you are notified by Niles.

In addition to all the information collected during the evaluation, recovery, and release activities, you will need to know the longitude and latitude for each site. Also, you'll need to know the Environmental Protection Agency (EPA) codes.

Natural Enemy Species Released 1989-1992 and the Environmental Protection Agency (EPA) Codes

Species	Acronym	EPA Code
Coleoptera: Coccinellidae		
<i>Adalia bipunctata</i> (Linnaeus)	AB	INAPABA
<i>Coccinellina ancoralis</i> (Germar)	CA	INAPCWA
<i>Coccinella septempunctata septempunctata</i> Linnaeus	CS	INAPAXA
<i>Coccinella transversoguttata biinterrupta</i> Mader	CT	INAPCVA
<i>Coleomegilla quadrifasciata</i> (Schoenherr)	CQ	INAPCXA
<i>Eriopis connexa</i> (Germar)	EC	INAPCYA
<i>Hippodamia tredecimpunctata</i> (Linnaeus)	HT	INAPAHA
<i>Hippodamia variegata</i> (Goeze)	HV	INAPBEA
<i>Oenopia conglobata</i> (Linnaeus)	OC	INAPCZA
<i>Propylea quatuordecimpunctata</i> (Linnaeus)	PQ	INAPBFA
<i>Scymnus frontalis</i> Fabricius	SF	INAPCTA
<i>Semiadalia undecimnotata</i> (Schneider)	SU	INAPCUA
Diptera: Chamaemyiidae		
<i>Leucopis ninae</i> Tanasijtshuk	LN	IOCSADA
<i>Leucopis atritarsus</i> Tanasijtshuk	LA	IOCSACA
Diptera: Syrphidae		
<i>Eupeodes nuda</i>	EN	
Hymenoptera: Braconidae (Aphidiinae)		
<i>Aphidius colemani</i> Viereck	AC	ISBUANA
<i>Aphidius matricariae</i> Haliday	AM	ISBUAJA
<i>Aphidius picipes</i> (Nees)	AP	ISBUAOA
<i>Aphidius rhopalosiphi</i> DeStefani-Perez	AR	ISBUAKA
<i>Diaeretiella rapae</i> (M'Intosh)	DR	ISBUAPA
<i>Ephedrus plagiator</i> (Nees)	EP	ISBUAMA
<i>Praon gallicum</i> Stary	PG	ISBUALA
Hymenoptera: Encyrtidae		
<i>Aphelinus asychis</i> Walker	AA	ISBLAKA
<i>Aphelinus</i> sp. nr. <i>varipes</i> (Foerster)	AV	ISBLAJA

Natural Enemy Species Released 1989-1992 and the Environmental Protection Agency (EPA) Codes (continued)

Species	Acronym	EPA Code
Crops		
alfalfa, <i>Medicago sativa</i>		23001
barley, <i>Hordeum vulgare</i>		28063
grasses (CRP)		22000
grasses (hay)		28066
oats, <i>Avena sativa</i>		28062
rangeland		28045
wheat, <i>Triticum spp.</i>		28065
Pests		
aphids, <i>Aphididae</i>		IRACAAA
Russian wheat aphid, <i>Diuraphis noxia</i>		IRACHUA







APHID BIOLOGICAL CONTROL RECOVERY  
DATA ENTRY REQUIREMENTS

PROGRAM: APHID BIOLOGICAL CONTROL .. RECOVERIES

01 Crop Data Record type . . . . . 01

Observation number. . . . .

State code. . . . .

County code . . . . .

Observation date. . . . . (YYMMDD)

Crop code . . . . . EPA Site Code

Source of data. . . . . (APHIS-11, State Dept. of Ag.-13,  
Extension-14)

02 Location Data

Record type . . . . . 02

Observation number. . . . .

Coordinate type . . . . . 2

Location coordinates. . . . . latitude-longitude in degrees, minutes,  
seconds 6 digits for latitude, 7 digits for  
longitude

09 Beneficial Organism

Record type . . . . . 09

Observation number. . . . .

Beneficial organism . . . . . EPA Pest Code

Host pest . . . . . EPA Pest Code

SMR . . . . . 74

A/I quantification. . . . . number recovered at the site

A/I descriptor. . . . . 534. . . . . (sweeps)

A/I descriptor amount . . . . . 100. . . . . (sweeps)

Figure 5-2--An Example of the Data Entry Requirements for Entering Recovery  
and Evaluation Survey Data into the NAPIS Database





Program:       APHID BIOLOGICAL CONTROL .. RELEASE

State: \_\_\_\_\_ County: \_\_\_\_\_ Date: \_\_\_\_\_

Crop: \_\_\_\_\_ EPA Crop Code: \_\_\_\_\_

Beneficial Organism: \_\_\_\_\_ EPA Code: \_\_\_\_\_

Pest: \_\_\_\_\_ EPA Code: \_\_\_\_\_

Survey Method Reference (SMR): Open field releases--enter 470  
Cage releases--enter 489

A/I Quantification: enter the number released at the site

A/I Descriptor: 698

A/I Descriptor Amount: 1 (one site)

Source of biological control agent code: \_\_\_\_\_  
(Code will be supplied by the Niles Lab)

Latitude (degrees/minutes/seconds) \_\_\_\_\_

Longitude (degrees/minutes/seconds) \_\_\_\_\_

EPA Codes are located on the back of this sheet

Figure 5-3--An Example of a Data Input Worksheet for Reporting Releases of Parasites and Predators. This worksheet may be used to summarize data from the FDWS.



APHID BIOLOGICAL CONTROL RELEASE  
NAPIS DATA ENTRY REQUIREMENTS

PROGRAM: APHID BIOLOGICAL CONTROL .. RELEASES

01 Crop Data Record type . . . . . 01

Observation number. . . . .

State code. . . . .

County code . . . . .

Observation date. . . . . (YYMMDD)

Crop code . . . . . EPA Site Code

Source of data. . . . . (APHIS-11, State Dept. of Ag.-13,  
Extension-14)

Observer ID . . . . . Enter code provided by Niles Lab. Code  
indicates source of biological control agents.

02 Location Data

Record type . . . . . 02

Observation number. . . . .

Coordinate type . . . . . 2

Location coordinates. . . . . latitude-longitude in degrees, minutes, seconds  
6 digits for latitude, 7 digits for longitude

09 Beneficial Organism

Record type . . . . . 09

Observation number. . . . .

Beneficial organism . . . . . EPA Pest Code

Host pest . . . . . EPA Pest Code

SMR . . . . . Enter 470 for open field releases  
Enter 489 for cage releases

A/I quantification. . . . . Enter number released at the site

A/I descriptor. . . . . 698. . . . . (release site)

A/I descriptor amount . . . . . 1. . . . . (one site)

Figure 5-4--An Example of the Data Entry Requirements for Entering Releases  
of Parasites and Predators into the NAPIS Database







APPENDIX 6--SUMMARY LIST OF RWA PROJECT RELEASE SITES

Release Site Number	County	Landowner	Release Year	Crop	Species	Number Released
AZ89.01	Cochise	Haas	1989	Barley	3	5,300
			1990	Barley	3	21,968
AZ89.02	Cochise	Miller	1989	Oats/alfalfa	2	11,534
AZ90.01	Greenlee	Pelto	1990	Barley	8	42,281
			1991	Barley	9	49,940
CA91.01	Imperial	Benson	1991	Alfalfa	12	231,543
CA91.02	Imperial	Teres Organic	1991	Wheat	12	111,663
CA90.01	San Joaquin	Shanks	1990	Wheat	9	64,485
CA91.03	San Joaquin	Aufdermaur	1991	Alfalfa	9	113,789
CA91.04	San Joaquin	Carlisle	1991	Barley	5	17,016
CA91.05	San Joaquin	Del Cardo	1991	Barley	15	105,349
C090.01	Arapahoe	Campfield	1990	CRP	9	25,739
			1991	CRP	11	64,402
C089.01	Mesa	Morlang	1989	Barley	3	3,900
			1990	Barley	3	10,883
			1991	Barley	7	37,046
C089.02	Rio Blanco	Sullivan	1989	Wheat	3	12,836
ID89.01	Power	Kopp	1989	Wheat	6	16,443
			1990	Wheat	8	25,017
KS91.01	Butler	Kidwell	1991	Sorghum	13	100,521
KS90.01	Ness	Blakely	1990	Wheat	12	34,178
KS89.01	Wallace	Koehn	1989	Wheat	5	16,636
MT89.03	Yellowstone	Hart	1989	Wheat	5	15,169
MT90.01	Yellowstone	Cellmer	1990	Wheat	12	59,386
			1991	Wheat	9	43,373
NE89.01	Banner	Stoddard	1989	Barley	3	13,100
NE90.01	Banner	Roberts	1990	CRP	8	35,586
NE89.02	Scotts Bluffs	Roberts	1989	Winter wheat	2	13,638
NE89.01	Curry	Coffee	1989	Wheat	3	3,000
NE89.02	Curry	Coffee	1989	Wheat	2	10,556
			1991	Wheat	11	39,861



Release Site Number	County	Landowner	Release Type and Year	Crop	Species	Number Released
NM90.01	Quay	Caton	1990	Wheat	8	45,234
NV90.02	Churchill	Ogden	1990	Barley	8	36,859
			1991	Barley	10	62,175
OK90.01	Beckham	Cochran	1990	CRP	12	53,743
			1991	CRP	9	49,912
OR90.01	Umatilla	Timmerman	1990	CRP	9	48,170
			1991	CRP	12	58,759
SD90.01	Fall River	Quivey	1990	Winter wheat	8	50,081
SD91.01	Pennington	Geigle	1990	Oats/Alfalfa	13	60,931
TX87.01	Deaf Smith	Detten	1987	Wheat	2	13,680
			1988	Wheat	2	12,627
			1989	Wheat	3	3,775
TX90.01	Potter	Henson	1990	Wheat	8	5,750
			1991	Wheat	11	45,322
TX90.03	Runnels	Odell	1990	CRP	8	25,790
TX91.01	Castro	Sides	1991	Wheat	11	53,522
TX91.02	Deaf Smith	Friemel	1991	Corn/Sorghum	11	34,766
UT90.01	Utah	Holbrook	1990	CRP	8	35,598
			1991	CRP	11	81,536
WA89.01	Adams	Blankenship	1989	Wheat	3	7,500
WA89.04	Douglas	Jorgeson	1989	Wheat	3	8,888
			1991	Wheat	12	20,141
WA89.05	Garfield	Clavanaugh	1989	Grasses	3	4,750
			1990	Grasses	9	34,774
WA89.06	Garfield	Klaveano	1989	CRP	2	1,100
WA89.07	Garfield	Morgan	1989	Barley	3	17,441
WA89.08	Garfield	WSU Res Farm	1989	Barley	3	7,800
WA91.01	Garfield	Koller	1991	Spring wheat	12	26,941

Release Site Number	County	Landowner	Release Type and Year	Crop	Species	Number Released
WA89.10	Lincoln	Booker	1989	Wheat	3	4,600
WA89.14	Walla Walla	Webb	1989	Crstd wh grass	2	3,300
WA90.01	Walla Walla	Burroughs	1990	CRP	5	10,200
WA90.02	Walla Walla	Walters	1990	Spring wheat	5	5,500
WA91.03	Walla Walla	Walters	1991	Wheat	14	22,943
WA91.04	Walla Walla	Walters	1991	Spring wheat	14	59,242
WY89.01	Goshen	Hubbs	1989	Wheat	3	5,500
			1990		9	34,010
WY89.02	Goshen	Kauffman	1989	Wheat	3	15,159
			1990		8	42,184
WY91.01	Goshen	WY Game & Fish	1991	Wheat	12	70,409
WY89.03	Laramie	Steege	1989	Wheat	6	15,020
			1990		10	40,886







APPENDIX 7--CONTENTS FOR RUSSIAN WHEAT APHID SURVEY PACKS

Russian Wheat Aphid Survey Pack--Packing List

<u>Item</u>	<u>Number</u>
Aspirator kit	1
Forceps for larval	2
Sorting tray	1
Resealable plastic bags - 8 x 10 with labels	75
Plastic bag - 6 x 18	25
Camel hair brushes	2
4 oz plastic jars with alcohol	75
Plastic capsules with attached caps	250
Sample labels	100
No. 2 pencil	4
Field Data Work Sheets (FDWS)	35
FDWS Attachment	35
Mailing tubes	35
Address labels - Addressed to Niles	25
Envelopes - Addressed to Niles	10









APPENDIX 8--LIST OF COUNTIES WHERE RUSSIAN WHEAT APHID  
(*DIURAPHIS NOXIA*) HAS BEEN DETECTED AS OF  
JANUARY 1, 1992 (LIST FROM NAPIS DATA BASE)

ARIZONA

Cochise	Greenlee	Pima	Yuma
Graham	Maricopa	Pinal	

CALIFORNIA

Alameda	Kings	Sacramento	Shasta
Butte	Lassen	San Benito	Siskiyou
Colusa	Los Angeles	San Bernardino	Solano
Contra Costa	Madera	San Joaquin	Sutter
Fresno	Merced	San Luis Obispo	Tulare
Imperial	Modoc	Santa Barbara	Yolo
Inyo	Monterey	Santa Clara	
Kern	Riverside	Santa Cruz	

COLORADO

Adams	Dolores	Las Animas	Pueblo
Alamosa	Douglas	Lincoln	Rio Blanco
Arapahoe	Eagle	Logan	Rio Grande
Archuleta	El Paso	Mesa	Routt
Baca	Elbert	Moffat	Saguache
Bent	Garfield	Montezuma	San Miguel
Boulder	Gunnison	Montrose	Sedgwick
Cheyenne	Huerfano	Morgan	Washington
Conejos	Kiowa	Otero	Weld
Costilla	Kit Carson	Ouray	Yuma
Crowley	La Plata	Phillips	
Delta	Larimer	Prowers	

## IDAHO

Bingham	Caribou	Jefferson	Payette
Blaine	Cassia	Latah	Power
Bonneville	Elmore	Lewis	Teton
Boundary	Franklin	Minidoka	Twin Falls
Butte	Fremont	Nez Perce	Valley
Camas	Gem	Oneida	Washington
Canyon	Jerome	Owyhee	

## KANSAS

Barber	Grant	McPherson	Rush
Barton	Gray	Meade	Russell
Cheyenne	Greeley	Mitchell	Saline
Clark	Hamilton	Morton	Scott
Cloud	Harper	Ness	Seward
Comanche	Haskell	Norton	Sheridan
Decatur	Hodgeman	Osborne	Sherman
Dickinson	Jewell	Ottawa	Smith
Edwards	Kearny	Pawnee	Stafford
Ellis	Kingman	Phillips	Stanton
Ellsworth	Kiowa	Pratt	Stevens
Finney	Lane	Rawlins	Thomas
Ford	Lincoln	Reno	Trego
Gove	Logan	Rice	Wallace
Graham	Marion	Rooks	Wichita

MONTANA

Beaverhead	Golden Valley	Musselshell	Sweet Grass
Big Horn	Granite	Park	Teton
Blaine	Hill	Petroleum	Toole
Broadwater	Jefferson	Pondera	Treasure
Carbon	Judith Basin	Powder River	Valley
Cascade	Lewis and Clark	Powell	Wheatland
Chouteau	Liberty	Richland	Yellowstone
Fergus	Madison	Rosebud	
Gallatin	McCone	Silver Bow	
Garfield	Meagher	Stillwater	

NEBRASKA

Arthur	Dawes	Hayes	Perkins
Banner	Dawson	Hitchcock	Red Willow
Box Butte	Deuel	Keith	Scotts Bluff
Chase	Dundy	Kimball	Sheridan
Cheyenne	Frontier	Lincoln	Sioux
Custer	Garden	Morrill	

NEVADA

Churchill	Eureka	Mineral	White Pine
Clark	Humboldt	Nye	
Douglas	Lincoln	Pershing	
Esmeralda	Lyon	Washoe	

NEW MEXICO

Bernalillo	Eddy	Mora	Santa Fe
Chaves	Grant	Otero	Sierra
Cibola	Guadalupe	Quay	Socorro
Colfax	Harding	Rio Arriba	Taos
Curry	Hidalgo	Roosevelt	Torrance
DeBaca	Lea	San Juan	Union
Dona Ana	Luna	San Miguel	Valencia

OKLAHOMA

Beaver	Custer	Kiowa	Tillman
Beckham	Dewey	Logan	Washita
Blaine	Ellis	Major	Woods
Caddo	Greer	Nobel	Woodward
Canadian	Harmon	Roger Mills	
Cimarron	Harper	Payne	
Comanche	Jackson	Texas	

OREGON

Baker	Grant	Morrow	Wallowa
Crook	Jefferson	Sherman	Wasco
Deschutes	Klamath	Umatilla	Wheeler
Gilliam	Malheur	Union	

SOUTH DAKOTA

Bennett	Haakon	Mellette	Stanley
Custer	Jackson	Pennington	
Fall River	Jones	Shannon	

TEXAS

Andrews	Dawson	Hutchinson	Randall
Archer	Deaf Smith	Irion	Reagan
Armstrong	Dickens	Jones	Reeves
Bailey	Donley	Kent	Roberts
Baylor	Ector	King	Runnels
Borden	El Paso	Knox	Schleicher
Briscoe	Fisher	Lamb	Scurry
Brown	Floyd	Lipscomb	Shackelford
Callahan	Foard	Lubbock	Sherman
Carson	Gaines	Lynn	Sterling
Castro	Garza	Martin	Stonewall
Childress	Glasscock	McCulloch	Swisher
Clay	Gray	Midland	Taylor
Cochran	Hale	Mitchell	Terry
Coke	Hall	Montague	Throckmorton
Coleman	Hansford	Moore	Tom Green
Collingsworth	Hardeman	Motley	Upton
Comanche	Hartley	Nolan	Wheeler
Concho	Haskell	Ochiltree	Wichita
Cottle	Hemphill	Oldham	Wilbarger
Crosby	Hockley	Parmer	Yoakum
Culberson	Howard	Pecos	Young
Dallam	Hudspeth	Potter	

UTAH

Box Elder	Grand	Sanpete	Wasatch
Cache	Juab	Sevier	Washington
Carbon	Millard	Summit	Wayne
Davis	Morgan	Tooele	Weber
Duchesne	Salt Lake	Uintah	
Emery	San Juan	Utah	

WASHINGTON

Adams	Ferry	Klickitat	Walla Walla
Asotin	Franklin	Lincoln	Whitman
Benton	Garfield	Okanogan	Yakima
Chelan	Grant	Pend Oreille	
Columbia	Kittitas	Spokane	

WYOMING

Albany	Fremont	Laramie	Park
Big Horn	Goshen	Lincoln	Platte
Campbell	Johnson	Natrona	Sheridan
Converse	Hot Springs	Niobrara	Washakie







APPENDIX 9--LIST OF KNOWN HOSTS OF THE RUSSIAN WHEAT  
APHID

Alkali sacaton, *Sporobolus airoides*  
Arizona fescue, *Festuca arizonica*

Barley, *Hordeum vulgare*  
Basin wildrye, *Leymus cinereus*  
Big bluegrass, *Poa ampla*  
Big bluestem, *Andropogon gerardii*  
Blue grama, *Bouteloua gracilis*  
Bluebunch wheatgrass, *Elytrigia spicata*  
Bermuda grass, *Cynodon dactylon*  
Buffalo grass, *Buchloe dactyloides*

Canby bluegrass, *Poa canbyi*  
Cane bluestem, *Bothriochloa barbinodis*  
Cheatgrass, *Bromus secalinus*  
Cheatgrass brome, *Bromus secalinus*

Fairway crested wheatgrass, *Agropyron cristatum*  
Foxtail grass, *Andropogon bicornis*  
Foxtail millet, *Setaria italica*

Green needle grass, *Stipa viridula*  
Intermediate wheatgrass, *Elytrigia intermedia intermedia*  
Japanese millet, *Echinochloa frumentacea*  
Jointed goatgrass, *Aegilops cylindrica*  
Kentucky bluegrass, *Poa pratensis*

Lehman lovegrass, *Eragrostis lehmanniana*  
Little bluestem, *Schizachyrium scoparium*

Meadow brome, *bromus erectus*  
Meadow foxtail, *Alopecurus prantensis*  
Mountain rye, *Secale montanum*

Nuttall alkaligrass, *Puccinellia airoides*  
Oats, *Avena sativa*  
Orchardgrass, *Dactylis glomerata*

Plains bluegrass, *Poa arida*  
Pubescent wheatgrass, *Elytrigia intermedia barbulatata*

Reed canarygrass, *Phalaris arundinacea*  
Russian wildrye, *Psathyrostachys jundeus*  
Rye, *Secale cereale*  
Rye grass, *Lolium multiflorum*

Sand dropseed, *Sporobolus cryptandrus*  
Sandberg bluegrass, *Poa secunda*  
Siberian wheatgrass, *Agropyron fragile*  
Side-oats grama, *Bouteloua curtipendula*  
Slender wheatgrass, *Elymus trachycaulus*  
Smooth brome, *Bromus inermis*  
Squirreltail, *Vulpia bromoides*  
Standard crested wheatgrass, *Agropyron desertorum*  
Steambank wheatgrass, *Agropyron riparium*  
Sudan grass, *Sorghum x drummondii*  
Switchgrass, *Panacum virgatum*

Tall fescue, *Festuca arundinacea*  
Timothy, *Phleum pratense*

Weeping alkaligrass, *Puccinellia distans*  
Western wheatgrass, *Elymus smithii*  
Wheat, *Triticum aestivum*





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RUSSIAN WHEAT APHID BIOLOGICAL CONTROL PROJECT  
COMMENT SHEET

Directions: Use this sheet to suggest an improvement or to identify a problem in the content of the manual. To mail, please follow the directions on the next page.

Description of problem (error, inconsistency, missing or insufficient information, etc.):

Description of improvement or recommended change (add attachments if necessary):

Reason for the improvement or change:

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AFTER COMPLETION, FOLD ON THE DOTTED LINES WITH THIS SIDE OUTWARD. STAPLE OR  
TAPE TO CLOSE. DROP IN THE MAIL; POSTAGE HAS BEEN PREPAID.

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UNITED STATES DEPARTMENT OF AGRICULTURE  
ANIMAL AND PLANT HEALTH INSPECTION SERVICE  
PLANT PROTECTION AND QUARANTINE PROGRAMS

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